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An Analysis of Alternative Policies for Dealing with New Source Growth in Nonattainment Areas: Oxidants Study Area: Houston-Galveston AQCR

Engineering-Science, Inc.
McLean, VA

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Oxidants

STUDY AREA: Houston-Galveston AQCR

Submitted to
U.S. Environmental Protection Agency
Office of Planning and Evaluation
Washington, D.C.

July 1980

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This study evaluates the potential of five air pollution control strategies to meet ozone attainment deadlines in Houston-Galveston. The scenarios analyze: 1) pre-1979 regulations, 2) A State Implementation Plan (SIP) based on Reasonable Available Control Technology (RACT), 3) A RACT SIP which requires emission offsets for new sources, 4) A RACT SIP which allows no major source construction after 1979, and 5) A SIP which bans construction after 1979 and requires existing sources to retrofit with Lowest Achievable Emissions Rate (LAER) technology.

The study's major conclusion: 1) Even with high levels of growth, the RACT scenarios substantially reduce hydrocarbons, 2) The existing 0.12 ppm ozone standard does not appear to be attainable, and 3) None of the scenarios ensure demonstration of reasonable further progress toward attainment by 1987.

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OXIDANTS

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CHAPTER I

INTRODUCTION

At the request of both the President and Congress, the U.S. Environmental Protection Agency (EPA) is undertaking a review of environmental policies in nonattainment air quality areas. At issue is how best to handle potential new source construction in areas currently exceeding the national ambient air quality standards (NAAQS), while ensuring expeditious attainment of the public health standards in a fair and effective manner.[1,2]

As a result of Congressional and Executive requests, EPA initiated several studies to evaluate the issues dealing with nonattainment and to evaluate policy alternatives. Houston-Galveston was selected as one of the study areas. It was not intended to substitute for the more detailed planning and analysis which the state agencies are required to conduct in preparing a revision of their State Implementation Plans (SIP). However, the analysis is a simulation of what the Texas Air Control Board (TACB) would have to perform in developing strategies to further reduce emissions in the Houston-Galveston area. The study is summarized in two volumes. Volume I is an analysis of policy alternatives and their impact on air quality levels of ozone and Volume II presents a parallel analysis for total suspended particulate (TSP).

The objective of this report (Volume I) was to evaluate the impact of various air pollution control startegies on future ozone levels. The original

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[1] The President's Environmental Message directed EPA to "review the current regulations controlling the construction of new facilities in areas not yet attaining air quality standards to ensure that these regulations will not interfere with the expeditious attainment of air quality levels required to protect public health. EPA is instructed to recommend a fair and effective policy for meeting these standards in the future".

[2] H.R. 6161 directed the Administrator and National Commission on Air Quality separately to report to Congress on the "air quality, health, welfare, economic, energy, and social effects" of the current Congressional, EPA, and alternate policies to deal with this issue. In the Conference Bill, this study provision for a further evaluation of the nonattainment problem appears as one of the required reports of the National Commission on Air Quality.

contract for this effort was started in February 1977 with the intent of analyzing certain growth issues associated with the Clear Air Act. Therefore, most of the data contained in this document are representative of the 1975-1976 period. Since the passage of the Clean Air Act Ammendments in 1977 and the submittal of State Implementation Plans in 1979, some changes have been made in the assumptions and methodology used in the study. However, the basic inventory data, estimates of new industrial emissions, and the degree of control technology available for these sources have not changed.

The analyses address two requirements of the Clean Air Act, namely the achievement of reasonable further progress and attainment of the new ozone standard.[1] It was assumed that air pollution control levels in existence or defined in new permits could be applied to all existing or new sources. The cost of controlling emissions was not considered in this study.

Several control strategy policy alternatives were evaluated using the Houston-Galveston AQCR as a study area. Analyses were performed for a base case, four key policies options, and several sensitivity scenarios. The policy alternatives are defined in the latter part of this chapter. The Houston-Galveston study area was selected by EPA because of its projected high growth potential, its publicized serious ozone problem, and the existence of a well documented emission inventory. Nonmethane hydrocarbons (NMHC) were studied because of their role in forming ozone and because the primary ozone health standards were exceeded in the study area. In recent years, the peak one-hour ozone level reached about two and one-half times the new 0.12 ppm ozone standard. This made it quite obvious that substantial reductions in hydrocarbon emissions would be required to demonstrate attainment of the standard.

The remainder of this chapter summarizes the study approach, the assumptions and limitations, the methodology used in the analyses, and the policy options. In addition, the report consists of five other chapters. Chapter II presents the conclusions of the study regarding ozone levels. Chapter III discusses the data used in the analysis, their origins, and the interpretations that were made in order to use the data in this study. Chapter IV summarizes the calculated reductions in NMHC emissions required to demonstrate reasonable further progress and attainment of the standard. Chapters V and VI present the resulting impacts of the policies studied on reasonable further progress and attainment, respectively. Detailed documentation, calculations, and original data used in the study are presented in six appendices to facilitate reading.

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[1] During the course of this study, EPA changed the oxidant standard of 0.08 ppm to 0.12 ppm, ozone. This study addresses the potential for attainment of the new ozone standard of 0.12 ppm. The potential for attainment with the old 0.08 ppm standard and an intermediate 0.10ppm is examined in a sensitivity analysis.

DESCRIPTION OF THE STUDY AREA

The EPA chose two representative ozone nonattainment metropolitan areas for an examination of alternative policies for dealing with new source growth: Houston-Galveston and Philadelphia. The Houston-Galveston area was selected for use in the analysis because it represents a southern U. S. City which is expected to have a high growth rate and its industrial mix differs from that of Philadelphia. The study area for this project was coincident with AQCR No. 216 which includes 13 counties in the metropolitan Houston-Galveston area. The 1975 population was about 2.5 milion for the entire AQCR.

Urban Character

Industrial manufacturing in the area is dominated by the petroleum refining and petrochemical manufacturing industries, although a number of food processing and other industries are included. Most of the industry is located in the city of Houston, along the ship canal which extends eastward about 50 miles to the the Gulf of Mexico, and also near the cities of Galveston and Texas City, Texas. Major new stationary sources are expected to locate in the future primarily in Galveston, Brazoria, and Matagorda Counties because of the availability of land and related transportation resources, pipelines, and other raw materials.

Air Quality

The 1977 Amendments to the Clean Air Act required that each state submit to EPA lists of areas which on August 7, 1977 did not meet a primary National Ambient Air Quality Standard (NAAQS), which had air quality better than any NAAQS, or for which there was not sufficient data for classification. At that

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[1] Federal Register, Vol. 43, No. 43, Friday, March 3, 1978.

time, the oxidant NAAQS was 0.08 ppm (one hour average) not to be exceeded more than once per year. On March 3, 1978, EPA published a list of those areas of the country which were not attaining NAAQS's.[1] Figure I-1 illustrates those areas in AQCR 216 which were not meeting the primary ambient air quality standard for oxidants of 0.12 ppm. These areas included Brazoria, Galveston, and Harris Counties. In accordance with the Clean Air Act Amendments, the states were to have developed and submitted to EPA revised oxidant SIP's by January 1, 1979. However, in January 1979, EPA revised the oxidant standard from 0.08 ppm to an ozone standard of 0.12 ppm. As a result of this revision, the air quality data for all designated nonattainment areas were re-examined. This review revealed that the three aforementioned counties were still nonattainment for ozone. A SIP reflecting the new ozone standard has been revised by the Texas Air Control Board (TACB) and submitted to EPA.

Nonattainment areas designated by the TACB and illustrated in Figure I-1 differed from the 13 county study area used in this analysis. It was doubtful that controlling hydrocarbon emissions in three of the 13 counties, without considering transport or some background factor, would improve ozone air quality proportionately. Analyses showed that 85% of the nonmethane hydrocarbon emissions of the 13 county area occurred in the three counties of Harris, Galveston, and Brazoria.

Growth Trends

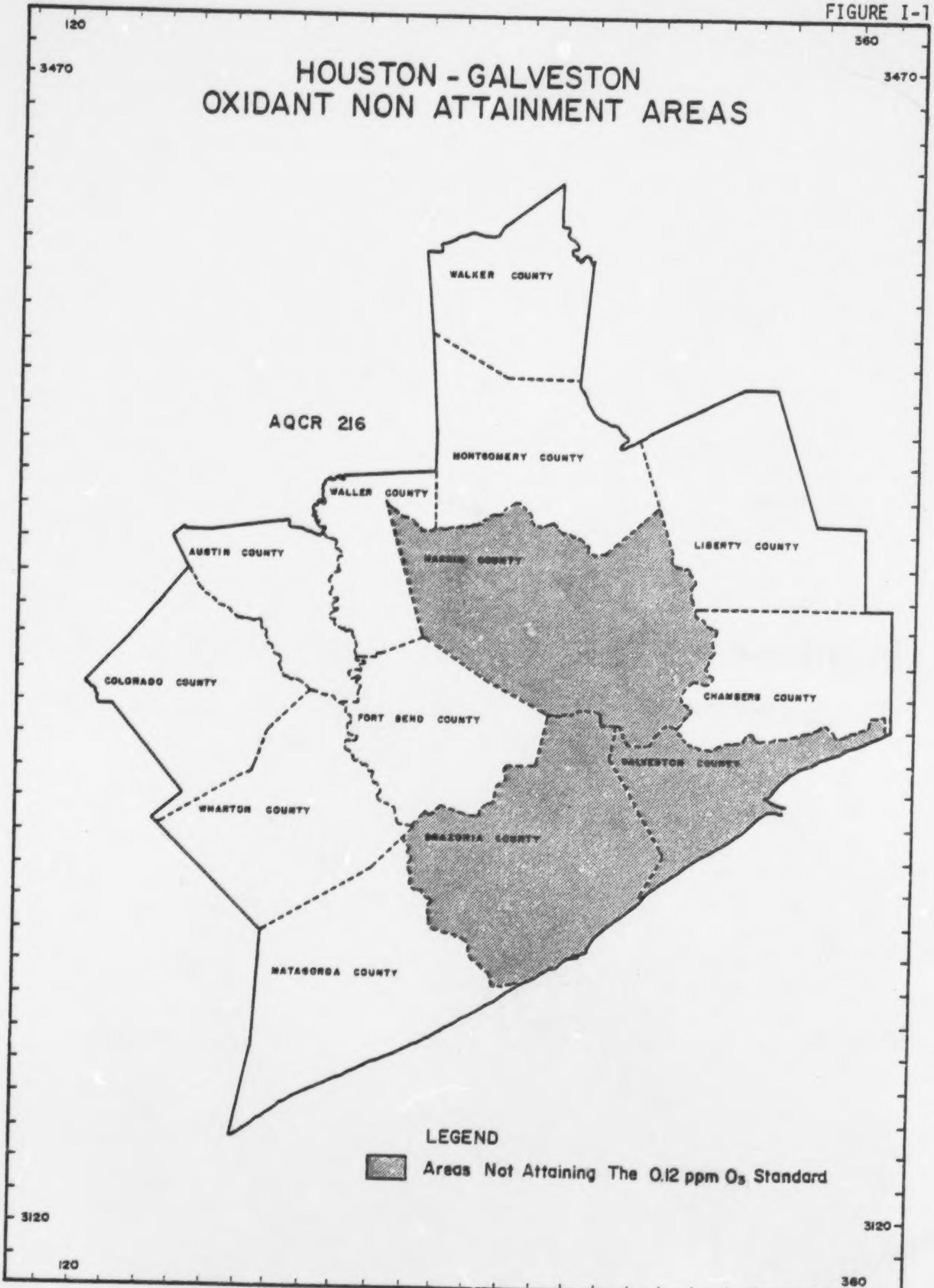
The Houston metropolitan area is one of the fastest growing areas in the nation. Some reports indicate that its population has increased by nearly 30% since 1970. This increase in population has been coupled with an increase in industrial activity in the Houston-Galveston AQCR. A number of state and local planning agencies are charged with the responsibility of estimating economic activity over the next few decades. Information that reflects industrial production expected between now and 1990 was obtained from these agencies. It was assumed that the growth trends experienced in the last decade would also prevail for the next 15 years. Appendix D describes the growth projections obtained and the manner of selecting those used in the study.

REQUIREMENTS OF THE 1977 CLEAN AIR ACT AMENDMENTS

The relevant requirements for nonattainment areas as set forth in the 1977 Clean Air Act Amendments can be summarized in four basic categories:

FIGURE I-1

HOUSTON - GALVESTON OXIDANT NON ATTAINMENT AREAS


120
360
3470
3470
AQCR 216
WALKER COUNTY
MONTGOMERY COUNTY
WALLER COUNTY
AUSTIN COUNTY
HARRIS COUNTY
LIBERTY COUNTY
COLORADO COUNTY
FORT BEND COUNTY
CHAMBERS COUNTY
GALVESTON COUNTY
WHARTON COUNTY
BRAZORIA COUNTY
MATAGORDA COUNTY
LEGEND
▨ Areas Not Attaining The 0.12 ppm O_3 Standard
3120
3120
120
360

1977 Clean Air Act Amendments can be summarized in four basic categories: reasonably available control technology, demonstration of attainment by new statutory attainment dates, reasonable further progress, and mechanisms to handle major source growth.

Reasonably Available Control Technology

The 1970 Clean Air Act required states to develop State Implementation Plans (SIP's) to attain and maintain national ambient air quality standards. These plans established emission limitations and other requirements as necessary to meet standards by the specified attainment dates. In nonattainment areas, revised SIP's were to have been submitted by January 1979 so that EPA could approve them by July 1979. The revised plans are required to impose measures representing reasonably available control technology (RACT) on stationary sources (see more detailed definition in Appendix F) and transportation strategies (reasonably available control measures) for mobile sources. Inspection and maintenance (I/M) programs for automobiles are necessary in areas which require extensions of up to 5 years to attain the ozone standard as described below.

Demonstration of Attainment by New Statutory Attainment Dates

Stage 1: 1979-1982

National ambient air quality standards must be attained as expeditiously as practicable. The 1977 Clean Air Act Amendments extended the statutory attainment dates to no later than December 31, 1982 for all pollutants. In the case of photochemiical oxidants (ozone) and carbon monoxide, Congress recognized the difficulty that areas with problems related to those two pollutants would have in demonstrating attainment by the earlier date. In such cases, an additional five years, to December 31, 1987, is permitted. If the additional five-year extension is needed, the state must submit a RACT SIP in 1979 and provide a list of additional measures necessary to demonstrate attainment by 1987.

Stage 2: 1982-1987

Where an extension has been granted, the state must adopt by 1982 the remaining enforceable measures necessary to attain standards by 1987 for photochemical oxidants (ozone) and/or carbon monoxide.

Restrictions

If a state is unable to submit a SIP that can demonstrate attainment of national standards and which can be approved by EPA, specific limitations on federal assistance are invoked under the Act including no major source construction after July 1979 and restrictions on federal funds for highways and wastewater treatment facilities.

Reasonable Further Progess

Prior to attainment of standards, the Clean Air Act Amendments call for interim progress in emission reductions on an annual basis, preferably in equal annual emmissions reductions which will provide for attainment by the statutory dates. There is an explicit requirement that to the extent possible these reductions should be realized in early years.

Mechanism for Handling Major Source Growth

Growth must take place within the framework of a plan which will achieve health based standards.

Prior to July 1979, the EPA offset ruling is in effect. There are two key conditions to the offset ruling:

- For every ton of emissions from a new source, there must be an offsetting emission reduction from existing sources sufficient to represent reasonable further progress (RFP) towards attainment; and
- New sources must meet the lowest achievable emission rate (LAER) which is the lowest rate achieved in practice or the lowest emission limitation set forth by any SIP for that same class or category of sources.

After July 1979, states are given a choice of two options as to how to handle new growth. The state can either:

- Create a quantitative margin for growth within the SIP by imposing emission limitations on existing sources to a greater degree than minimally necessary to meet standards; or
- Continue some form of case by case emission offset approach.

In many cases, the states will provide for a combination of both approaches. With either option, new major sources must meet LAER.

As will be discussed below, the first of these requirements, reasonably available control technology, is assumed to be part of each of the policy options under study. The fourth element under the Clean Air Act Amendments, mechanisms for handling new major source growth, will vary amongst the policy options. The second and third elements of the 1977 Clean Air Act Amendments are used to evaluate each policy option in light of its ability to meet these two requirements: reasonable further progress and demonstration of attainment by the new statutory dates. In order to evaluate the extent to which policy options meet these two criteria, these requirements are interpreted with respect to current EPA policy in general and how they apply to the case study area in particular.

DESCRIPTION OF POLICY OPTIONS

The various policy alternatives examined in the study included: a base case analysis, four key policy option analyses, and seven sensitivity analyses in which the effect of alternate assumptions was tested. A number of assumptions were made regarding the various levels of control and growth. The policy options were selected by the EPA to represent the full range of impacts and were not intended to represent real policy choices under active consideration. For these analyses, an attempt was made to make the evaluations as realistic as possible. For all policy options examined, offsets were assumed to be required and obtained during the period 1977 through 1979 as required by the Act.[1] Thus, for the "no-growth" policies, growth was assumed to be curtailed after 1979.

For the base case and each of the four policy options, a control technology level was assigned to each of the emission source categories (Table I-1). Major sources were separated into three separate groups: existing, new, and replacement. Mobile sources were addressed separately and included all road vehicles (such as cars, trucks, motorcycles, and buses) and other mobile sources (such as off-road vehicles, airplanes, ships, boats, and rail locomotives). Minor point and area sources were aggregated into the remaining source category. The control levels that were assigned to the various point and area source categories for each of the policy options included pre-1979 SIP control levels[2], reasonably available control technology (RACT), and

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[1] The interpretative ruling for the offset policy was issued on December 21, 1976.

[2] Control technology permitted under the pre-1979 SIP, much of it more stringent than required.

TABLE I-1

CONTROL TECHNOLOGY ASSUMPTIONS USED FOR POLICY ANALYSES

	EMISSION SOURCE CATEGORY				
	MAJOR				
FUTURE SCENARIO	EXISTING	REPLACEMENTS	NEW	MOBILE	MINOR/ AREA
I: Pre-1979 SIP with Major Source Construction	SIP	LAER	LAER	FMVCP	SIP
II: RACT SIP with Major Source Construction	RACT	LAER	LAER	FMVCP Strong I/M	RACT
III: RACT SIP with Offsets for Major Source Construction	RACT[1]	LAER	LAER	FMVCP Strong I/M	RACT[1]
IV: RACT SIP with No Major Source Construction after 1979	RACT	LAER	N/A	FMVCP Strong I/M	RACT
V: LAER Replacement with No Major Source Construction after 1979[2]	LAER	LAER	N/A	FMVCP Strong I/M 20% TCP[3]	RACT-2

[1] In order to provide offsets, it was assumed that, as needed, these source categories can be further reduced beyond the RACT SIP. Existing major sources would reduce to LAER and Area/Minor sources would reduce to RACT-2.

[2] This scenario assumed that all existing sources were controlled to the maximum possible levels.

[3] A 20% Transportation Control Plan assumed a 20% decrease in vehicle miles traveled and a corresponding 20% decrease in emissions.

lowest achievable emission rate (LAER) as defined earlier (RACT-2 for area sources). The three levels of control assigned to mobile sources included the Federal Motor Vehicle Control Programs (FMVCP) as scheduled under the Clean Air Act Amendments of 1977, a "strong" inspection and maintenance (I/M) program (defined by formal training of inspectors reviewing vehicles and a 30% stringency factor), and a 20% transportation control plan (a 20% reduction in vehicle miles traveled).

The base case, the four policy options and the sensitivity scenarios are defined in more detail in the ensuing discussion.

I: Pre-1979 SIP with Major Source Construction

A base case analysis was first performed to illustrate the potential impacts if the pre-1979 SIP were not revised and major source construction took place using LAER controls. The following assumptions were made for the base case analysis for each of the source categories:

o Major New Stationary Sources	- Growth was projected with LAER controls and no offsets were required after 1979.
o Major Existing Stationary Sources	- Production was limited to 1975 levels and the pre-1979 SIP emission regulations were applied to this source category.
o Minor and Area Stationary Sources	- Growth was projected to continue with the pre-1979 SIP emission regulations.
o Mobile Sources	- Growth was projected to continue with controls from the current FMVCP. No transportation control plans or I/M programs were assumed to exist.

II: RACT SIP with Major Source Construction

This policy option required a revision of the SIP in which all existing sources to be regulated at RACT levels. The RACT controls were phased in according to the initial EPA guideline schedules for issuance of Control Technology Guidelines.[1] All major new source construction was regulated to insure LAER controls. No offsets were required after 1979. The following assumptions were made for each of the source categories:

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[1] Walsh, Robert T., Release of Guidelines for Sources of Volatile Organic Compounds. November 22, 1977.

o Major New Stationary Sources	- Growth was projected with LAER controls and no offsets were required after 1979.
o Major Existing Stationary Sources	- Production was limited to 1975 levels and sources were retrofitted with RACT level controls.
o Minor and Area Stationary Sources	- Growth was projected to continue with RACT level controls.
o Mobile Sources	- Growth was projected to continue with controls from the current FMVCP and a strong I/M program (one that has formal training of mechanics repairing vehicles).

III: RACT SIP with Offsets for Major Source Construction

This policy option assumed that all existing sources were required to meet RACT controls through SIP revision regulations. All major new source contruction met LAER controls and obtained offsetting emission reductions. The available pool of offsets included emission reductions from existing sources to RACT levels only until the promulgation of a revised SIP. Later, existing sources were assumed to be controlled to the LAER level, thus providing additonal offsets. That is, sources were assumed to reduce emissions from pre-1979 SIP to RACT over the next two years and then further reduce emissions to LAER beginning in 1981. Given the expense of retrofitting twice (from pre-1979 SIP to RACT and then RACT to LAER), this assumption is unlikely. For simplicityu of analysis, it was assumed that the offset pool was fully tradeable and that such emission reductions could be carried over until needed. The following assumption were made for each of the source categories:

o Major New Stationary Sources	- Growth was projected with LAER controls and offsets were required from 1977 to 1980.
o Major New Stationary Sources	- Growth was projected with LAER controls and offsets were required from 1977 to 1990.

- Major Existing Stationary - Production was limited to 1975 levels and sources were retrofitted first with RACT level controls and later with LAER controls.
- Minor and Area Stationary - Growth was projected with controls controls and later with RACT-2 level controls for additional offsets.
- Mobile Sources - Growth was projected controls from the current FMVCP and a strong I/M program (one that has formal training of mechanics repairing vehicles.)

IV: RACT SIP with No Major Source Construction After 1979

This policy option attempted to demonstrate the effect of curtailing all major source construction and controlling existing sources with RACT. Although area, minor, and mobile sources were permitted to maintain the projected growth rates, emissions were expected to decrease because of better controls on existing sources and turnover to less polluting vehicles. The following assumptions were made for each of the source categories:

- Major New Stationary Sources - No major source construction.
- Major Existing Stationary Sources - Production was limited to 1975 levels and sources were retrofitted with RACT level controls.
- Minor and Area Stationary Sources - Growth was projected with RACT level controls.
- Mobile Sources - Growth was projected with controls from the current FMVCP and a strong I/M program (one that has formal training of mechanics repairing vehicles).

V: LAER Replacement with No Major Source Construction After 1979

This policy option was hypothetical. It assumed that all existing sources were replaced by 1990 with new sources having the same production capacity, but using LAER control technology. No net growth of major source capacity was allowed. The following assumptions were made for each of the source categories:

- Major New Stationary Sources - No major source construction.
- Major Existing Stationary Sources - Production was limited to 1975 levels and sources were retrofitted with LAER level controls.
- Minor and Area Stationary Sources - Growth was projected with RACT-2 level controls (see Appendix C for definition).
- Mobile Sources - Growth was projected with controls from the current FMVCP a strong I/M program, and 20% reduction in vehicle miles traveled.

SENSITIVITY ANALYSES

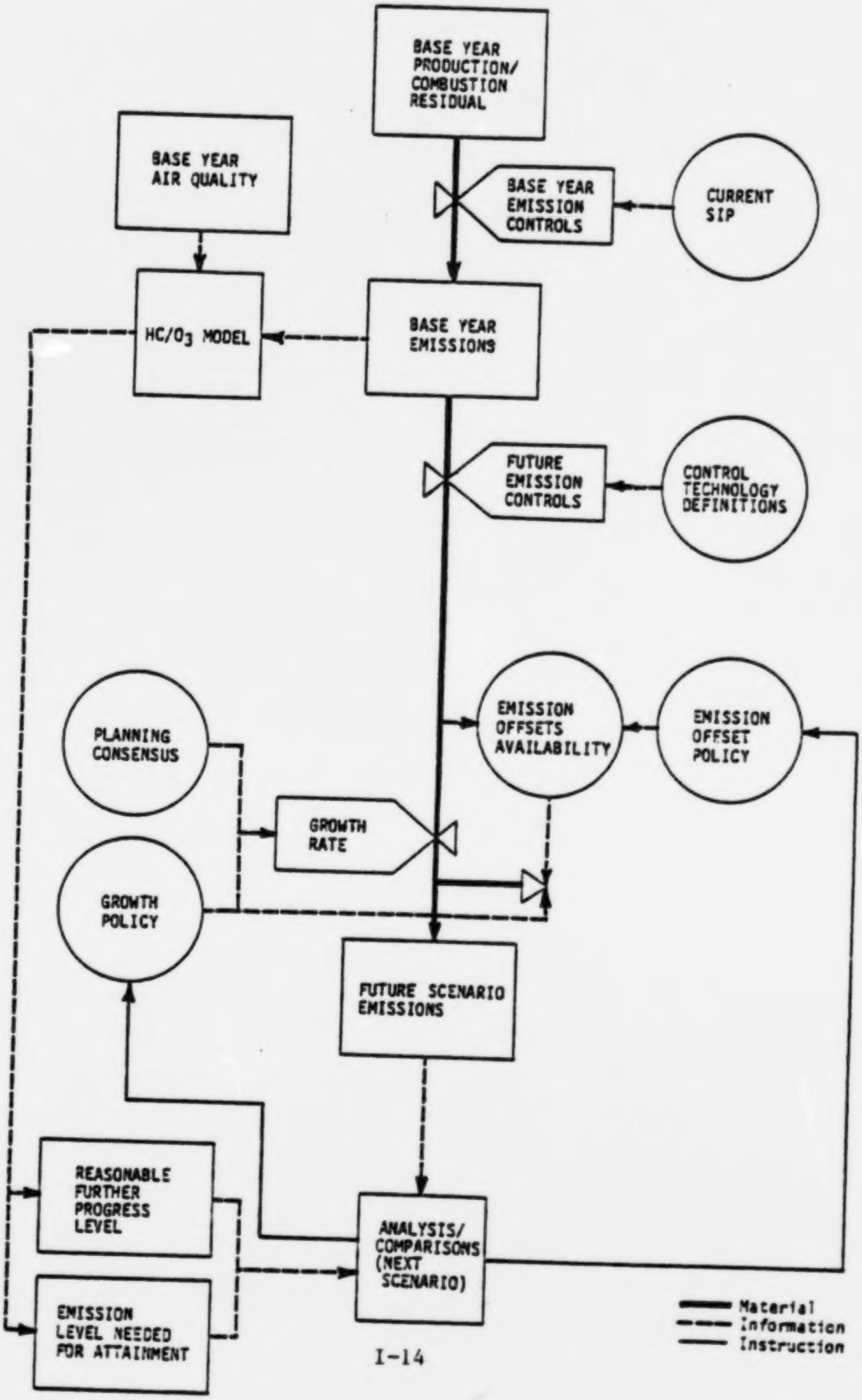
Sensitivity analyses were conducted to determine the impact on subsequent findings and conclusions of alternate assumptions. These included:

1. The accuracy of the emission inventory base;
2. The growth rates of major new stationary sources;
3. Control technology definitions;
4. The accuracy of projected future motor vehicle emissions factors;
5. Reservoir of intra-industry tradeoffs;
6. The selected ozone standard (0.08, 0.10, 0.12 ppm); and
7. The method used to calculate the reduction in emissions necessary to meet the standards.

DESCRIPTION OF THE METHODOLOGY

Figure I-2 is a schematic diagram representing the study methodology. It defines qualitatively the relationship between emission levels, present and future, and the policy alternatives under study here. In addition, it depicts the role of growth factors and control technology definitions as values regulating the growth of emissions. In this study, two empirical models have been used to estimate the changes in hydrocarbons and oxidant levels. Figure I-2 depicts the way new emission levels were determined in

FIGURE I-2
STUDY METHODOLGY


BASE YEAR PRODUCTION/ COMBUSTION RESIDUAL
BASE YEAR AIR QUALITY
BASE YEAR EMISSION CONTROLS
CURRENT SIP
HC/O_3 MODEL
BASE YEAR EMISSIONS
FUTURE EMISSION CONTROLS
CONTROL TECHNOLOGY DEFINITIONS
PLANNING CONSENSUS
EMISSION OFFSETS AVAILABILITY
EMISSION OFFSET POLICY
GROWTH RATE
GROWTH POLICY
FUTURE SCENARIO EMISSIONS
REASONABLE FURTHER PROGRESS LEVEL
ANALYSIS/ COMPARISONS (NEXT SCENARIO)
EMISSION LEVEL NEEDED FOR ATTAINMENT
Material
Information
Instruction

the study and not the way real world emission levels are actually reached. The validity of the study, however, depends upon the realism of the assumptions made, especially on the key relationship of hydrocarbons and their role in forming ozone. Other factors such as growth rates and control technology definitions are all critical in demonstrating attainment of the present 0.12 ppm ozone standard. Sensitivity analyses, which consider alternate assumptions, test and extend the validity of this study.

The base year used in this analysis was 1975. Three future years (1980, 1985, and 1990) were used for projections of emissions and air quality. The results also were analyzed for 1982 and 1987, two key attainment dates specified in the Clean Air Act Amendments of 1977, and for incremental results on an annual basis.

Base Year Inventory

Emission inventories were compiled for point, stationary area, and mobile sources. Point source inventories were obtained from the appropriate control agencies, reviewed, and checked for consistency between production/combustion levels, uncontrolled emission factors, emission control efficiency, and emissions. Emissions which were judged to be entirely methane were deleted from the inventory. No attempt was made, however, to remove the methane fraction from complex emissions such as might come from a crude oil storage tank.

The point source inventory compiled had a reference year of 1975. A 1973 NEDS emission inventory was obtained from the Texas Air Control Board and updated to 1975. The emissions data provided were disaggregated into three main categories and then further divided into nonmethane and methane emissions. The three main emissions categories were: regulated, unregulated, and fugitive. The update from 1973 to 1975 was accomplished through the use of questionnaires and personal visits to major sources to obtain confidential emissions information. The control agencies and industrial contacts confirmed the currency of the operational data. Upon completion of this review, the compilation was considered the base year point source emission inventory.

An area source emission inventory had been developed for this region by the Texas Air Control Board (TACB) for a 1973 base year. This was reviewed, validated or modified as necessary, and updated to base year 1975. The TACB inventory did not include emissions from dry cleaning and asphalt paving cutbacks. Hydrocarbon emissions for these sources were estimated using EPA's AP-42, Compilation of Air Pollutant Emissions Factors.

Mobile sources had not been included in the TACB area source inventory. Therefore, annual estimates of vehicle miles traveled (VMT) were obtained from the Houston-Galveston Regional Transportation Study (HGRTS) Office and the State Department of Highways and Public Transportation. These were applied to emission factors appropriate to the 1975 base year and travel characteristics provided by the same transportation planners. The composite emission factors were calculated by EPA's new mobile source emission factor program, MOBILE 1.

The emission inventories prepared for the base year and additional details of the compilation methodology are presented in Appendix E.

Future Scenario Controls

Assumptions were made as to the level of control that could be applied to existing and new sources in order to fix the reduction in hydrocarbon. emissions that could be achieved by increased control. These assumptions specified RACT and LAER level controls for point sources by the National Emissions Data Systems (NEDS) Source Classification Code (SCC) by assigning either a controlled emission factor or a control efficiency to the source for each level of control. These assignments were based on data from several general references, other EPA contractors, and discussion with EPA's Office of Air Quality Planning and Standards (OAQPS). A considerable effort was made to collect all of the limited data available. Still, these control technology definitions were not intended to reflect actual standards that could be required by state regulations of specific sources. Nor was any attempt made to forecast how control technology might improve with time.

Area sources, stationary and mobile, were also considered, though they are not (with the exception of highway vehicles) traditionally controlled sources. Again, assumptions were made as to the level of control which would constitute RACT and RACT-2 for area sources. Again, controlled emission factors or control efficiencies were specified. In the case of highway vehicles, the FMVCP emission reductions were considered to define actual emissions in any future year; RACT controls were considered to be a strong inspection maintenance program (I/M) which implies 30% stringency and mechanics training; and RACT-2 controls required a 20% transportation control plan (a 20% reduction in vehicle miles traveled) in addition to the strong I/M.

These control technology definitions are discussed in greater detail in Appendix C. The list of emission factors/control efficiencies by SCC is also presented there.

Future Scenario Growth

Estimates of growth rates for major new industrial sources were obtained from a number of local planning agencies and two other EPA contractors. Industrial growth in the Gulf Coast region was allocated to the Houston-Galveston area based upon the share of industrial production in the 13 county AQCR. The recommended EPA methodology for calculating replacement rates was used which is based upon simplifying assumptions and appeared to produce rapid turnover rates. For this study, analyses were made assuming (1) no replacement and (2) using the rapid replacement rates calculated by the EPA methodology.

Figure I-2 shows the growth rate to be set by "planning consensus". Actually, a considerable effort was expended to obtain plant-specific, even process-specific, growth projections with little success. A wide range of estimates was obtained when individuals from industry were solicited for the outlook in their own SCC. Projections for point sources were made by selecting a mid-range value and the extremes were considered in sensitivity analyses. Growth projections for area sources were mainly guided by standard statistical projections of governmental agencies.

Further details on growth factors, including a listing of the factors actually used in the study, are presented in Appendix D. Projected emissions based on these growth factors are given in Appendix E.

Policy Alternatives

The policy alternatives selected by EPA represented a broad range of options available to the states to attain air quality and manage new emissions growth effectively. Some options required only RACT controls on existing sources and LAER on new sources while other options required the tightest possible controls on all sources. In one policy option, continuation of the EPA offset policy was examined; while in another, the effect of not permitting new major source construction was considered. Each policy option resulted in different emission levels because of the different control levels set, the need to offset emissions or not, and the amount of growth being considered. Each of these conditions was preset for each scenario as specified earlier.

As of November 1977, the EPA had issued a schedule for issuance, adoption, and implementation of guidelines for control of sources of volatile organic compounds. The schedule is reproduced in Appendix C. For this study, it was assumed that the state concerned would adopt this schedule, issue SIP revisions for specific sources, and require compliance according to this schedule. This affects the availability of ACTUAL to RACT offsetting emissions because once the reduction is required by the SIP revision the source cannot be used to offset new emissions. More importantly, however, is the delay which has been experienced in the issuance of Control Technique Guidelines (CTG) since completion of this study. The EPA has revised by six months the deadlines for submittal of the RACT regulations for the second set. The SIP's should now provide for the adoption and submittal of additional legally enforceable regulations by July 1, 1980 for the source categories contained in this second set. Moreover, delays have developed regarding the remaining CTG's because of the time required for the regulatory adoption process. These delays were anticipated and are addressed in a sensitivity analysis.

Future Scenario Emissions

Emission control factors and growth factors were applied to base year emissions according to the dictates of the policy alternatives of the future scenario under study. The methodology for applying emission control factors to point source emissions is presented in Appendix B. An IBM 370/158 computer was utilized for computational assistance and data processing to the degree possible. However, some hand processing of point source data obtained late and of area and mobile source data was necessary. The new emission level, reduced by any offsetting emission reductions used, constituted the future scenario emissions in any year.

The emissions from 1979 to 1982 and the level reached by 1987 were focal points of the study. The comparison of emission levels at these times with the emission levels needed to demonstrate reasonable further progress and attainment by 1987 was the primary impact analysis of each future scenario (economic and social aspects are considered in other companion studies).

ASSUMPTIONS AND LIMITATIONS

The following paragraphs contain a listing of some of the basic assumptions underlying the analysis which tend to limit the validity of the results, some of the technical difficulties encountered, and the means used to overcome these difficulties. Finally, a list of CAVEATS is presented.

Limiting Assumptions

1. Underlying the entire study is the assumption that hydrocarbon emissions anywhere in the AQCR contribute equally to ozone levels. That is, there is no source-receptor relationship. In fact, the spatial distribution of the emissions determines, for given meteorology, the distribution of hydrocarbon concentration. This should result in a horizontal field with local ozone maxima and minima, rather than a uniformly high concentration as assumed.

2. A related assumption considers all nonmethane hydrocarbons to be equal contributors to ozone production. Reactivity surely plays some role here even though it is poorly understood. Furthermore, no other contaminant is considered to contribute to or inhibit ozone production except in as much as the EKMA model shows NO_x levels affect the hydrocarbon-ozone interaction.

3. Emissions are rarely projected directly and so projection of employment, earnings, and activity levels such as production were used to provide surrogate parameters for emissions growth. It was assumed that such factors are in direct proportion to emissions. In some instances this assumption is sound, as in the case of dry cleaning emissions being proportional to population; in other cases it is not sound, as in the case of employment level being proportional to emissions in a chemical manufacturing process.

4. It was assumed that growth demand would not be affected by the policy alternatives considered. That is, whenever a policy allowed major source growth it was assumed that, no matter what control or offset conditions were stipulated, the growth would take place. Furthermore, minor source and area source growth took place at the same rate in each future scenario. In fact, the control policies would change the economic factors which affect investment

decisions, equipment retirement decisions, and other growth decisions.

5. The assumption was made that RACT and LAER controls could be retrofitted on any existing source and achieve the same emissions control level as on new sources. In fact, new plant technology may involve a process modification or other hardware changes that would be difficult or impossible to install at an existing plant. Moreover, existing equipment process design on plants may limit options for installing the RACT controls assumed here. Costs were not taken into account.

6. The assumptions that offsets were available in exactly the amount required and at the time required is unrealistic. For the purpose of the study, it was assumed that the pool of all possible emission reductions was freely accessible to new growth. Any residual reduction was available for future use unless the pool was eliminated by a SIP revision. Because processes have basic production units with a modular size which have both intra- and inter-industry variation, these assumptions tended to overestimate available offsets.

Technical Difficulties

1. Where available, existing inventories reported hydrocarbon, not non-methane hydrocarbon (NMHC) emissions. Because of the very low reactivity of methane, it is EPA policy to eliminate methane from the inventory. The point source processes listed were reviewed to determine whether the effluent was primarily methane or not. For example, natural gas combustion products were eliminated when they alone made up the effluent. Mixtures were not reduced by an estimated methane fraction, however.

2. Reported petroleum storage emissions loss in several instances was inconsistent when the material stored was considered. Storage of No. 6 residual oil or slop oil will be accompanied by only small loss because of the low vapor pressure. Review and adjustment was made where indicated. When high vapor pressure products were stored, overestimation of the evaporation loss was evident. This is because emission estimates for fixed and floating roof tanks based on the API Method published in AP-42[1] have been shown to be

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[1] Compilation of Air Pollutant Emission Factors, Supplement 7, U. S. EPA, OAWM, OAQPS, Research Triangle Park, N. C.

too high by a factor fo 2 to 3 in an independent study by ES.[2] Emissions from these sources were reduced by 60% if they had fixed roofs, 50% if they had floating roofs.

Caveats

1. The Houston-Galveston AQCR was studied to assist in formulating national policy. Nothing contained in this report is intended to reflect EPA's judgment of policy needs for the Houston-Galveston region.

2. Assumptions made in control technology definitions were ad hoc assumptions necessary for the study to proceed. They do not represent EPA guidelines for any industry or process nor do they purport to be useful for any other purpose than this study.

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[2] Hydrocarbon Emissions from Floating Roof Petroleum Tanks, by Engineering-Science, Inc., Arcadia, California, prepared for Western Gas and Oil Association, Los Angeles, California 91107, January 1977.

CHAPTER II

SUMMARY AND CONCLUSIONS

An analysis was made of several policy options for the Houston-Galveston AQCR to determine the best method for handling new source growth in this nonattainment area. Measured ozone air quality in the area was over twice the standard. The current EPA methodology for attaining the ozone standard calls for the reduction of nonmethane hydrocarbon (NMHC) emissions. The ozone design value established by the control agency affected was 0.27 ppm which establishes a required NMHC emission reduction of 59% to attain the 0.12 ppm standard if the modified rollback method of estimation is used. Using the EKMA procedure, a reduction of 64% is required to attain the standard. It is recognized that alternate models might establish different emission reduction goals.

A NMHC emission inventory was compiled for major point, mobile, stationary area, and minor point sources. Growth expectations were established in consultation with local planning agencies and industrialists. In order to achieve reductions in NMHC, assumptions were made on the level of control that could be applied to major point, mobile, stationary area, and minor point sources. The RACT and LAER control technology definitions used in this study were developed from literature searches and reviewed by EPA's Emission Standards and Engineering Division (ESED). The analysis proceeded by applying growth and control increments (decrements) to the appropriate emission category as required over the period by the various policy options.

After establishing the base or "no action" case, the study considered a RACT SIP, a RACT SIP with 1:1 and 3:1 offsets, and two no-growth scenarios. The study period was 1975 through 1990 focusing on the question of reasonable further progress in 1982 and attainment no later than 1987. The policies represent a broad range of options which could be available for control officials in meeting Clean Air Act requirements.

The major conclusions of the study can be summarized as follows:

- Even with the high levels of growth, overall hydrocarbon emissions can be reduced substantially using reasonable available control measures.

The 1975 emission levels could be reduced between 7 and 54% by 1987 by implementing the policy options analyzed in this study.

- The existing 0.12 ppm ozone standard does not appear to be attainable. On paper, the Houston-Galveston area under the complete LAER replacement with no major source construction after 1979 policy option does show attainment using modified linear rollback. However, this policy option was a hypothetical "best case analysis" and not a realizable policy. Attainment of the new standard is only possible under some of the other policy options if much better controls are developed and implemented for all existing sources -- control beyond the RACT and LAER study assumptions. Such RACT/LAER controls covered about 200 industrial categories; EPA has issued RACT guidance for about 15 industrial categories. In order to show attainment, such control technology would have to be about up to 50% tighter, depending upon the policy option, than was assumed in this study.
- Regarding reasonable further progress (RFP) towards compliance with the 0.12 ppm ozone standard, the various policy options analyzed can not meet this requirement. In the early years (1979-1985), sufficient reductions can be realized for progress towards attainment to be made; but, emissions reductions in the later years (1985-1987) are not sufficient to meet either the EPA's RFP requirement or provide attainment of the standard.

CHAPTER III

DATA INPUTS USED FOR ANALYSES

This chapter provides a summary of the data used to conduct the policy analyses for this study. The data were comprised of four basic elements:

- Emission inventories;
- Control technology definitions;
- Growth projections; and
- Replacement rates of production facilities.

The appendices of this report contain detailed information concerning the methodologies and sources used in compiling the data base.

The purpose of this chapter is to define the resulting data summaries, identify how they were used in the analyses, and focus on the key elements affecting the policy analyses. Each of the above data bases is discussed separately. Emission inventories are discussed in two parts. The base year emission inventory reflects the data that were used to define present conditions. A comparison is made with the Texas Air Control Board (TACB) inventory. Lastly, a SIP allowable discussion addresses the baseline emission inventory used to calculate offsets.

BASE YEAR EMISSION INVENTORIES

For this analysis, the nonmethane hydrocarbon (NMHC) emission inventory was divided into three specific categories which are used throughout this report:

- Major point sources;
- Mobile sources; and
- Stationary area/minor sources.

The emission inventory used in the study was based upon the 1975 questionnaire data from the TACB. Information from other local data sources was obtained directly in order to calculate transportation, area, and minor source emissions. In addition, some minor adjustments were made to the TACB inventory (e.g., to reflect new information on emission factors for three source categories). A specific description of the methodology used to generate emissions and a more detailed tabulation of emissions by minor category and smaller geographic area is presented in Appendix E. A sensitivity analysis was later conducted for the policy options considered using the original emission data compiled by the TACB.

Major Point Sources

A summary of the NMHC point source emission inventory used in this study appears in Table III-1 and is defined in terms of five general industrial categories. The inventory reflects emissions in the base year 1975. Fugitive hydrocarbon emissions for the larger major point sources are included in the emissions information presented. There were about 200 different industrial processes in the inventory. The main categories used in this study are shown in Table III-1. These data are based upon questionnaires and differ somewhat from the TACB inventory. The 1975 actual emissions are also presented as if these were controlled to RACT or LAER levels (see Appendix C for RACT and LAER definitions). A later discussion compares the two data bases. In addition to the 1975 inventory, Table III-1 also identifies the projected growth in emissions in 1980, 1985, and 1990 assuming all new emissions were controlled to LAER levels.

The major source emissions appearing in the baseline inventory total 181,710 tpy or approximately 53% of the entire inventory. A recent court ruling on June 18, 1979 (Alabama Power Company vs. Costle, 13 ERC 1225) defined major sources as those emitting greater than 100 tpy of potential controlled emissions. However, for the purpose of this study, major point source emissions were defined as those greater than 50 tpy of actual emissions in the base year 1975. Figure III-1 illustrates the percentage of emissions of the categories comprising the major sources. The figure also shows emissions as defined in TACB terms: regulated, unregulated, fugitive, and storage tank emissions. Regulated sources are defined as sources which are presently considered under the TACB Article V Regulations. Unregulated sources are defined as those sources which are not addressed by specific regulations. Sources permitted after 1973 were required to use best available control technology (BACT) and are included in the unregulated definition. Fugitive sources are those which do not emit directly from stacks or vents (e.g., cooling towers, API separators, pumps, valves, compressors, and flanges). Of the 181,710 tpy of major source emissions, approximately 50% were determined to be emitted by chemical manufacturing. Figure III-1 also shows that 44% of the total emissions from major industrial sources were from fugitive sources as defined by TACB.

TABLE III-1

A COMPARISON OF 1975 ACTUAL, RACT, LAER, AND ADDITIONAL LAER NONMETHANE HYDROCARBON EMISSIONS FROM MAJOR POINT SOURCE GROWTH

INDUSTRY/PRODUCT/PROCESS	DATES: SIP REVISION/ COMPLIANCE	1975 EMISSIONS (tons/year)			ADD'L LAER EMISSIONS (tons/year)^{a}		
		ACTUAL	RACT^{c}	LAER^{c}	1980	1985	1990
CHEMICAL MANUFACTURING							
Ethylene	1980/1984	3,362	1,811	1,811	1,300	3,060	5,400
Olefins (including some ethylene)	↑	1,793	851	851	500	1,180	2,080
Low Density Polyethylene		9,951	6,546	2,877	500	1,210	2,250^{b}
High Density Polyethylene		11,201	10,807	940	610	1,520	2,620^{b}
Ethylene Dichloride		1,941	195	195	680	1,540	2,640
Ethylene Oxide		34	19	19	220	510	880
Propylene Oxide	↓	404	81	81	20	50	80
Polypropylene	1980/1984	2,971	2,551	859	540	1,360	2,750^{b}
Vinyl Chloride	1979/1982	6,438	128	83	10	20	40
Polyvinyl Chloride	1979/1982	8,480	3,556	3,119	40	80	140
Butadiene - Styrene Synthetic Rubber	1980/1984	6,131	858	858	160	350	550
Carbon Black	↑	9,486	509	0	0	0	0
Styrene		443	87	87	160	370	650
Formaldehyde		565	198	123	40	80	150
Acetaldehyde		1,163	1,163	1,163	890	2,210	4,140
Acetic Acid		320	83	83	0	0	0
Acetone^{c}		643	162	162	30	70	110
Cyclohexanone	↓	2,733	2,733	743	380	940	1,770^{b}
Caprolactam	1980/1984	530	193	193	0^{d}	0^{d}	0^{d}

TABLE III-1

A COMPARISON OF 1975 ACTUAL, RACT, LAER, AND ADDITIONAL LAER FOR NONMETHANE HYDROCARBON EMISSIONS FROM MAJOR POINT SOURCE GROWTH (Cont'd)

INDUSTRY/PRODUCT/PROCESS	DATES: SIP REVISION/ COMPLIANCE	1975 EMISSIONS (tons/year)			ADD'L LAER EMISSIONS (tons/year)[a]		
		ACTUAL	RACT[c]	LAER[c]	1980	1985	1990
CHEMICAL MANUFACTURING (cont'd)							
Ethylbenzene	1980/1984	54	8	8	0	0	10
Ammonia	↕	47	12	12	0	10	20
Glycerine(and assoc. products)		3,389	2,973	2,973	940	2,030	3,290
Alkylated Liquor Distillation		1,851	1,783	1,783	500	1,150	1,970
Sulfuric Acid		1,878	0	0	0	0	0
All Other Chemicals	1980/1984	15,689	7,580	7,580	2,040	4,640	7,960
SUBTOTAL		(91,497)	(44,887)	(26,603)	(9,560)	(22,380)	(39,500)
PETROLEUM REFINING							
Fluid Catalytic Cracking	1979/1982	5,422	1,830	1,830	0	0	0
API Separators	1979/1984	577	577	577	60	130	200
Cooling Towers	1979/1984	1,905	953	953	0	0	0
Valves, Pumps, & Fugitive Losses	1979/1984	19,625	9,813	9,813	680	1,430	2,350
Natural Gas Processing	1982/1986	1,568	1,568	1,568	0	0	0
PAINTING (ALL INDUSTRIES)	1982[c]/1986	2,884	577	288	70	150	250
LOADING							
Gasoline (Including Aviation Gas)	1980/1984	8,584	1,246	726	50	110	170
Crude	1979/1982	6,248	4,485	54	0	0	10
Other Petroleum Products	1982/1986	111	20	16	0	0	0
Chemicals	1981/1986	1,461	337	284	80	170	300

TABLE III-1

A COMPARISON OF 1975 ACTUAL, RACT, LAER, AND ADDITIONAL LAER FOR NONMETHANE HYDROCARBON EMISSIONS FROM MAJOR POINT SOURCE GROWTH (Cont'd)

INDUSTRY/PRODUCT/PROCESS	DATES: SIP REVISION/ ATTAINMENT	1975 EMISSIONS (tons/year)			ADD'L LAER EMISSIONS (tons/year)[a]		
		ACTUAL	RACT[c]	LAER[c]	1980	1985	1990
OTHER POINT SOURCES							
Boilers (Including Turbines)	NA	160	160	160	40	80	140
In-plant Vehicles	NA	403	403	403	90	210	350
Process Heaters	NA	23	23	23	0	10	20
Other Metals Manufacturing	1979/1982	1,041	10	10	10	20	30
Incinerators	NA	5	5	5	0	0	0
Miscellaneous		12,257	12,257	12,257	1,180	2,620	4,380
STORAGE TANKS							
Petroleum	1979/1982	17,657[e]	9,996	6,087	610	1,260	1,940
Chemical	1981/1986	10,282[e]	8,088	6,870	1,900	4,320	7,420
GRAND TOTAL		181,710	97,235	68,527	14,330	32,890	57,060

[a] Represents the additional emissions due to new growth from 1975.

[b] LAER control factors were based on recent permit data submitted to the TACB. EPA's ESED reviewed and approved these factors.

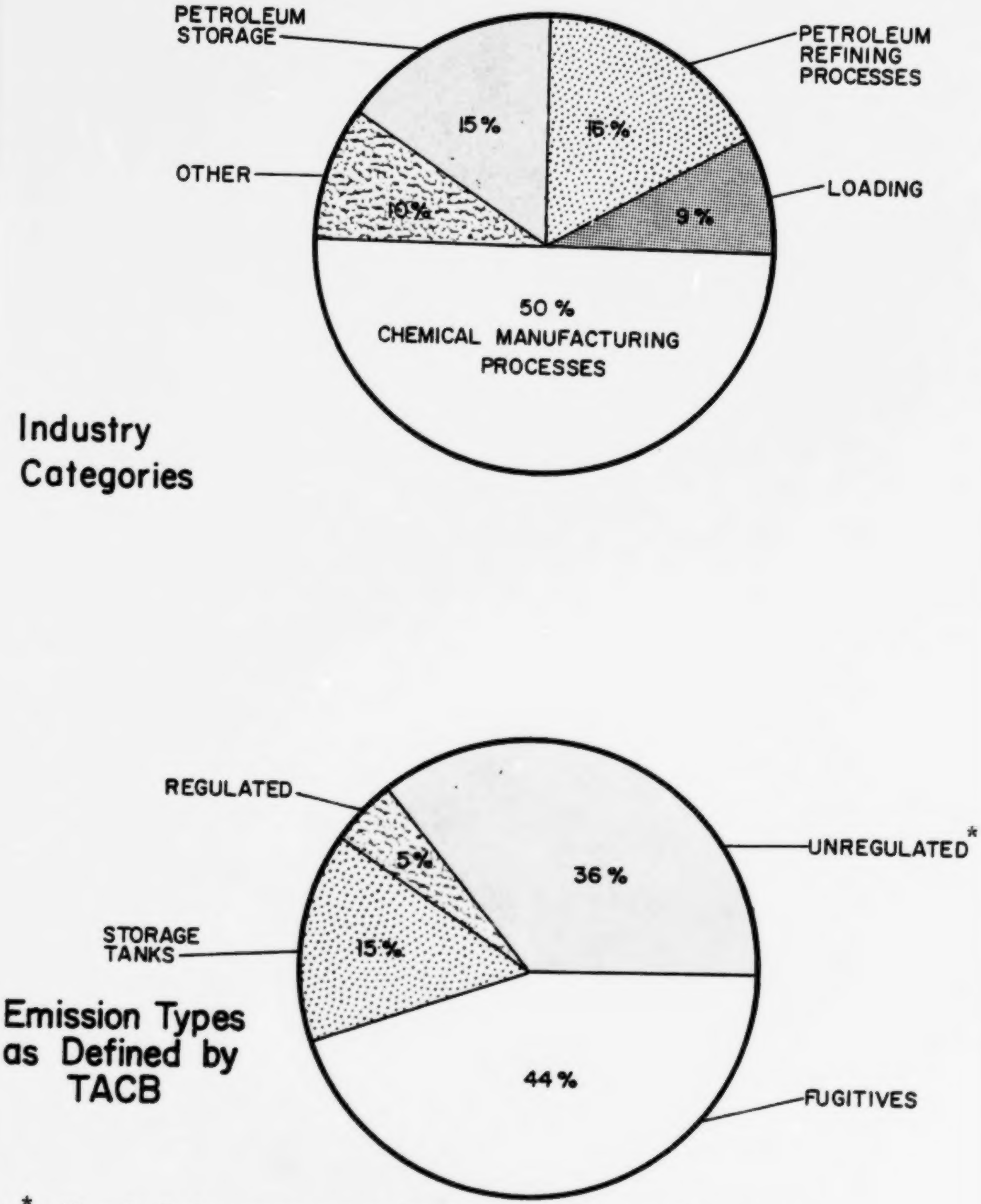
[c] In some cases, there were no LAER factors available for the chemical industry. As a result, LAER and RACT emissions were assumed to be the same.

[d] No growth.

[e] These estimates were based on recent field studies completed by ES. EPA is currently reviewing these data and re-evaluating the API equations used to estimate HC loss. Using the API methodology, emissions would have been: petroleum - 28,509 tpy; chemical - 16,584 tpy.

FIGURE III-1

MAJOR SOURCES



* Also includes sources permitted after 1973 which have BACT.

Mobile Sources

Mobile source emissions were 134,381 tpy in 1975 or 39% of the total inventory including off-highway sources such as construction, farm vehicles, ships, pleasure boats, aircraft, and railroads. Motor vehicle emissions were calculated by EPA's Office of Transportation and Land Use Policy (OTLUP) using the MOBILE 1 emission factor program and current vehicle miles traveled (VMT) data which were obtained mainly from the Houston-Galveston Regional Transportation Study (HGRTS) office.

An average travel rate was calculated by using the VMT and population. The average was 20 miles per person per day for this area. This figure is higher than for most cities, however, it is within the order of magnitude for certain western cities (e.g., Los Angeles 16; San Diego 16; Denver 12; and San Francisco 14).

Table III-2 summaries the mobile source emissions data for the baseline year and the change in emissions projected for 1980, 1985, and 1990. For example, the actual emissions are projected to decrease from 134,381 tpy in 1975 to 76,903 tpy in 1985 assuming only the FMVCP is in effect on the road vehicle portion of the mobile category.

Stationary Area/Minor Sources

Area source emissions totaled 25,477 tpy in 1975 or 8% of the total NMHC inventory. There were four major area source categories: surface coating, gasoline marketing, dry cleaning, and asphalt paving (see Table III-2).

Actual emissions in 1975 were projected to increase through 1990 by approximately 41% if it was assumed that no further controls were added other than those that existed in the base year.

Minor source emissions were defined as those less than 50 tpy of actual emissions in the base year 1975. These totaled 2,395 tpy for the entire AQCR or approximately 1% of the entire inventory. These emissions were estimated to increase by approximately the same amount as the area source category; however, because the 1975 actual emissions were relatively small, this category is projected to remain insignificant.

Total Emissions

These four categories of emissions totaled 343,963 tpy for base year 1975. Figure III-2 illustrates the makeup of the emission categories used in this analysis.

TABLE III-2

SUMMARY OF MOBILE, AREA, AND MINOR SOURCE EMISSIONS FOR THE HOUSTON-GALVESTON AQCR

(NMHC TONS/YEAR)

CATEGORY				EMISSIONS CHANGES OVER 1975 INVENTORY								
	1975			1980			1985			1990		
	ACTUAL[a]	RACT	RACT-2[f]	UNC[i]	RACT	RACT-2[f]	UNC[i]	RACT	RACT-2[f]	UNC[i]	RACT	RACT-2[f]
Area Sources:												
Surface Coating	5,746	1,149	575	872	175	87	1,617	324	161	2,312	463	231
Gasoline Marketing	12,843	2,312	899	1,536	276	108	3,261	577	228	5,200	936	364
Dry Cleaning	2,827	418	283	426	233	42	795	306	79	1,138	375	114
Paving	1,990	398	199	1,326	99	133	1,326	99	133	1,326	99	133
Other	2,071	2,071	2,071	192	192	192	368	368	368	529	529	529
Subtotal	25,477	6,348	4,027	4,352	975	562	7,367	1,684	969	10,505	2,402	1,371
Mobile Sources:[d]	134,381[g]	134,381[g]	134,381[g]	-16,576[g]	-16,576[g]	-16,576[g]	-57,478[g]	-67,698[c]	-77,624[e]	-71,377[g]	-86,387[c]	-93,024[e]
Minor Sources:[b,h]	2,395	2,395	--	550	550	--	1,227	1,227	--	2,060	2,060	--

[a] Actual emissions as reported.

[b] No change in control technology from existing RACT was assumed for minor sources.

[c] Auto emissions were calculated using FMVCP emission limits, a strong auto inspection and maintenance program which started in 1982, and no transportation control plan.

[d] Mobile emissions for 1980, 1985, and 1990 showed decreases even though there was an increase in VMT of 110% between 1975 and 1990. The 1975 total was 18,138; 1980 was 23,990; 1985 was 30,062; and 1990 was 38,038 million vehicle miles traveled per year.

[e] Includes a 20% reduction in VMT with a transportation control plan in addition to the FMVCP and a strong inspection and maintenance program.

[f] Although LAER does not apply to area sources, RACT-2 was designated for tighter controls on area sources.

[g] Automobile emissions assuming only the FMVCP was in effect.

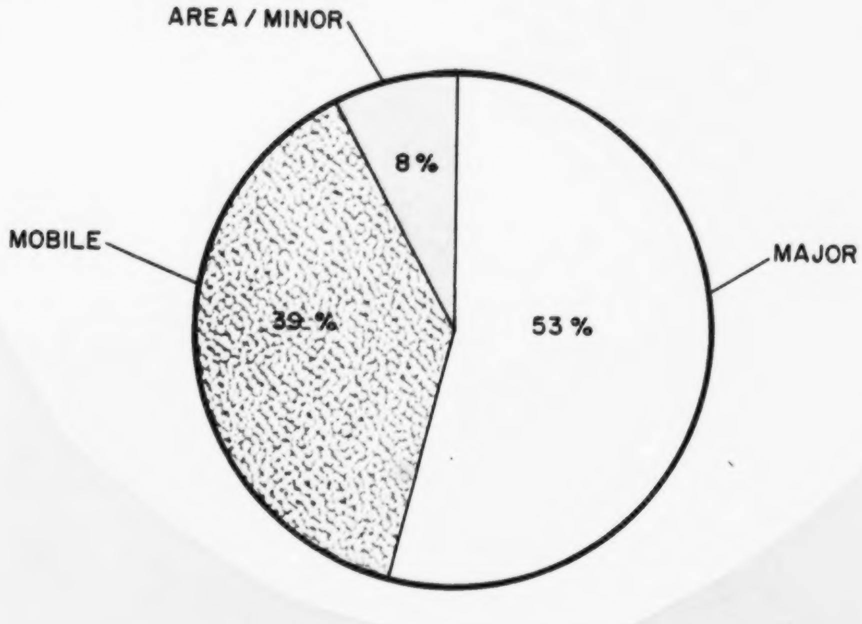
[h] Minor sources include field pumping stations, agricultural dryers, rendering plants, refractory manufacturing, etc.

[i] No additional controls were assumed other than those which existed in the base year.

FIGURE III-2

1975 BASE YEAR EMISSION INVENTORY OF NON-METHANE HYDROCARBONS

Major Sources	181,710 Tons/Yr.
Mobile Sources	134,381 Tons/Yr.
Area / Minor Sources	27,872 Tons/Yr.
Total	343,963 Tons/Yr.



COMPARISON OF EMISSION INVENTORIES USED IN STUDY WITH THOSE USED IN TACB REPORTS

In November 1977, the TACB published a summary of all the NMHC emissions for the entire state. This document was reviewed and the inventory used in the analysis was compared with the TACB's published summary. The comparison is presented in Table III-3.

Major Point Sources

For the chemical and metal manufacturing categories, there were little differences between the data used in this study and the data previously compiled by TACB. A difference of about 13,000 tpy for petroleum refining resulted from adjustments made in this study in order to correct the estimated emissions from one of the API separators in the inventory. According to the TACB, the reported data were probably in error by 13,000 tpy. Other API separators in the area had average emissions of 600 tpy.

For petroleum storage, emissions used in this analysis were 17,000 tpy lower than those reported by the TACB. The TACB emissions from petroleum storage were modified by assuming that emissions were 50% of those calculated by the API equation. This assumption recognized more recent information on hydrocarbon losses from storage tanks which had been generated by API, WOGA, SOHIO, and others.

There was a small difference noted in the loading and unloading of petroleum and chemical compounds when comparing the inventory used in this study with the TACB inventory.

In summary, the total major point source emissions used for this study were 181,710 tpy. According to the TACB compilation, such emissions totaled 209,103 tpy (7% higher).

Mobile Sources

Mobile source emissions in the November 1977 TACB inventory were about 17,000 tpy less than the emissions calculated for this study. The difference resulted primarily from the use of new EPA emission factors; the TACB used the older emission factors from Supplement 3 of AP-42 and 1975 VMT data.[1]

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[1] During this study, differences in the estimates of VMT were resolved between EPA and the TACB. The VMT used in this study is identical to the TACB data.

TABLE III-3

COMPARISON OF 1975 EMISSION INVENTORIES
(TONS PER YEAR)

	INVENTORY USED IN THE ANALYSIS	TACB COMPILATION[a]
Major Sources		
Chemical Mfg.	91,497[h]	89,638
Petroleum Refining	29,097[b]	41,408
Metal Mfg.	1,041[h]	1,031
Petroleum Storage	27,939[c]	45,093
Petroleum Loading	16,404[h]	15,916
Other[d]	15,732[h]	16,017
Total Major Sources	181,710	209,103
Mobile Sources	134,381(e)	116,782
Area Sources	25,477[f]	17,193
Minor Point Sources	2,395[g]	(not reported)
TOTAL	343,963	343,078

[a] "Oxidant Attainment Analysis - Emission Inventory Data," TACB Report, Austin, TX, November 24, 1977.

[b] An adjustment was made to the questionnaire data for one API Separator. Emission from one source was reported as 13,103 tpy--probably in error according to TACB. Emissions from this source were not included in this analysis.

[c] Emissions from existing petroleum storage without secondary seals were recalculated using factors obtained by ES in a study completed for WOGA. EPA is currently reviewing the emission factor for petroleum storage. In general, when using the API methodology, HC emissions are overstated by 50%. For new tankage work by SOHIO, API and others suggest that HC emissions can be as low as 10-15% of that calculated using the API equation.

[d] Other refers to those emissions which could not be lumped into the categories above.

[e] ES used the new Supplement 8 emission factors (MOBILE 1) to estimate the emissions from this category. In addition, VMT data were obtained from the Texas DOT and Highway District #12 (H-GRTS).

[f] ES added emissions from dry cleaning and asphalt paving.

[g] Emissions from other sources which were not included in the major point sources. This summary was developed from emission sources included in a 1974-1975 NEDS computer tape obtained from TACB.

[h] Based on 1975 questionnaire data collected by TACB.

Stationary Area/Minor Sources

Area source emissions differed by about 8,000 tpy. The primary difference occurred in two categories of the area sources: dry cleaning and cutback asphalts. These two source categories were not included in the TACB inventory. Additional data were collected to calculate these emissions. As a result, 8,000 tpy were added to the original TACB estimate.

Minor point sources were not reported by the TACB. These data were summarized based on some older information collected from the TACB for the calendar year 1974. Minor point source emissions totaled 2,395 tpy.

Total Emissions

Nonmethane hydrocarbon emissions for 1975 that were used in this analysis totaled 343,963 tpy in 1975. By comparison, the TACB inventory for the same source categories totaled 343,078 tpy. Small differences and adjustments were noted but offsetting adjustments resulted in extremely similar overall emissions estimates for the study area.

SIP ALLOWABLE EMISSIONS

This study was based on actual emissions reported by TACB and modified for this study. An attempt also was made to establish the SIP allowable emission level for each source category; however, for a number of reasons this could not be accomplished. By statute, the SIP allowable level is the baseline for calculating emission offsets. However, where the SIP is too vague to provide a baseline for such calculations, the EPA emission offset policy calls for the use of actual emissions. This was the case in Houston-Galveston.

When calculating the emission reductions as a result of applying tighter controls (e.g., with the adoption of a RACT SIP), actual emissions were used rather than SIP allowable levels to determine the overall reductions. Similarly, when emission offsets were required, the actual emissions from a source were used as the baseline.

None of the TACB hydrocarbon regulations specified a maximum emission limit based either on production or an emission rate over some time period (e.g., tons/day).[1] Data contained on permits issued by the TACB could have been used to establish maximum allowable emissions for some source categories. However, EPA Region VI had determined that these rates were not the same as a "SIP allowable" rate and, therefore, they were not used in this study.

CONTROL TECHNOLOGY DEFINITIONS

RACT and LAER definitions are summarized in Appendix C for more than 200 different industrial processes. These definitions were applied to each stack/source in the inventory and then summed to determine emissions over the entire AQCR. If a source already had controls which were better than the RACT/LAER assumptions used in this analysis, no change in RACT/LAER emissions was calculated. Thus, for this analysis, application of RACT or LAER controls could only reduce emissions.

There were no LAER definitions for 41% of the 1990 major source emissions growth. In these cases, the RACT factor was used for analytical purposes. In some instances, a RACT definition was not available either. This amounted to about 22% of the base year emissions. When no RACT factor was available, or where production or other information necessary to use the RACT factor was unavailable, emissions were still reduced for that process (using default values), but perhaps not by as much as would be assumed if specific information were available. Figure III-3 provides an indication of the percentage of base year (1975) point source emissions for which RACT/LAER control technology definitions were specified in Appendix C.

GROWTH IN EMISSIONS

Major Point Sources

Table III-1 shows the increase in NMHC emissions expected for each major point source category. Growth data were obtained from a number of different sources, including local and state planning agencies, other EPA contractors, and recently published articles in technical journals as explained in Appendix D. By knowing the production rates in the base year and the anticipated growth, growth in any future period could be predicted. The additional production was assumed to correspond proportionately to an increase in emissions. In this

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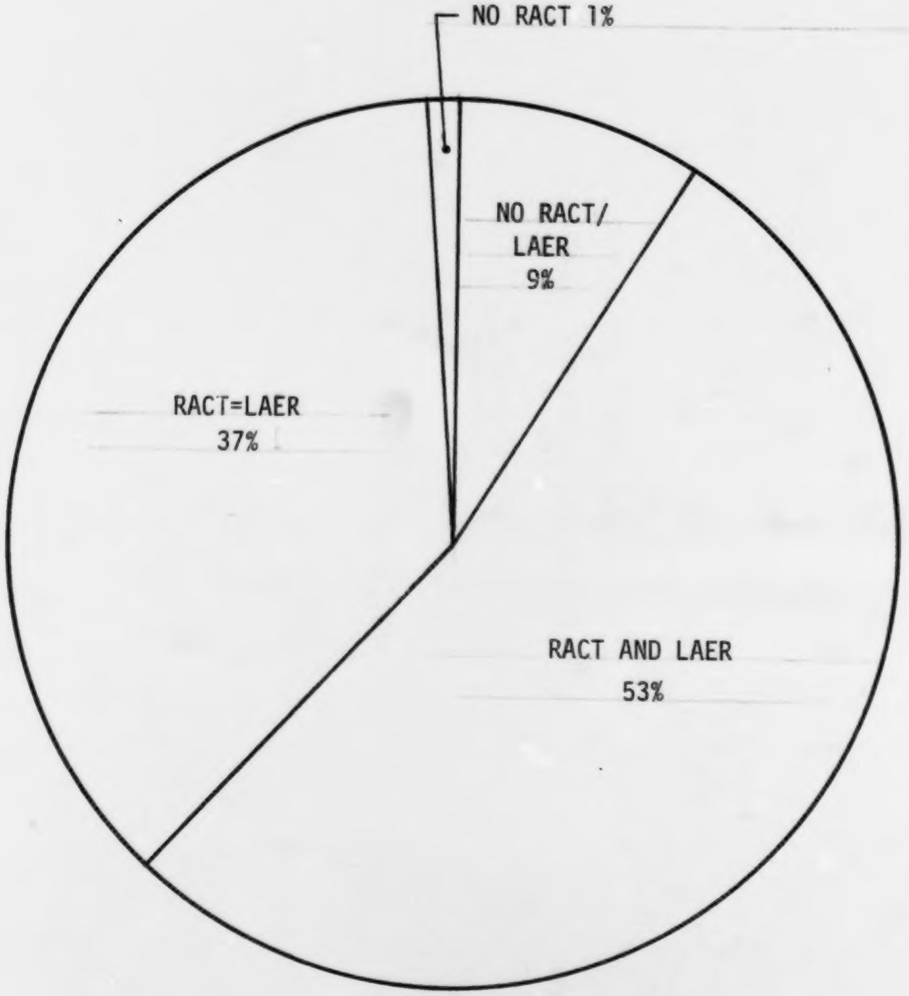
[1] Some regulations require an abatement system if the emissions are more than 200 lb/day, but this regulation still does not set a maximum hourly or daily emission rate.

RACT/LAER COVERAGE [1]
HOUSTON-GALVESTON AQCR



[1] PERCENT OF TOTAL POINT SOURCE EMISSIONS COVERED BY CONTROL TECHNOLOGY DEFINITIONS.

analysis, all new major source growth was assumed to use controls. This is consistent with the present policy in Texas which requires Best Available Control Technology (BACT) on new sources. Major point source growth expected between 1975 and 1990 was 57,060 tpy. This represents almost a doubling of all production over existing conditions in this 15-year period. The chemical industry is projected to grow at 6% per year and the petroleum refining industry is expected to increase emissions at about 2% per year.

Mobile Sources

Table III-2 summarizes the emission reductions for mobile sources in 1980, 1985, and 1990. Although there is expected to be a 100% increase in the vehicle miles traveled, mobile source emissions are expected to decrease substantially between 1975 and 1990 because of the Federal Motor Vehicle Control Program (FMVCP). The reduction in emissions which results from the FMVCP is far greater than the potential increase due to increased travel. In 1985, it was also assumed that aircraft emissions would begin decreasing (through the end of the study year 1990) because of better controls. This would result in an overall reduction of 71,377 tpy by 1990 even if there were no change in existing regulations. Application of more stringent regulation (RACT-2) could bring about a reduction of 86,387 tpy of NMHC by 1990.

Beginning in 1990, however, an upward trend in mobile source emissions occurred. This was because the phase-in of new automobiles is complete in 1990 and new auto travel is not offset by better controls on cars.

Stationary Area/Minor Sources

Table III-2 also summarizes the additional NMHC emissions attributable to area and minor point sources growth for 1980, 1985, and 1990. If no changes were made to existing regulations, the NMHC emissions from area/minor sources might increase by 12,565 tpy in 1990. Application of RACT or RACT-2 to this category could limit the increase to 4,462 or 1,371 tpy by 1990, respectively.

Growth to Capacity for Major Point Sources

Throughout this report, all existing facilities were assumed to remain at 1975 production levels for all scenarios. This discussion addresses the question of the growth in capacity that was available in the study area.

Not all industrial processes were operating at the maximum possible production levels in 1975. In general, chemical manufacturing plants were operating at about 75% of the design capacity according to data contained in the TACB questionnaires. Petroleum refineries, on the other hand, were operating at about 95+% of capacity. If desired, the increase to capacity would be calculated by assuming that the production in the chemical industry would increase from 75 to 95% of capacity. The 1975 total actual emissions could reach a theoretical level of 209,625 tpy (27,915 above the tabulated level of 181,710 tpy). If all existing sources were to be replaced with LAER or if the expansions were subjected to LAER requirements, the existing processes would emit an additional 7,093 tpy because of the expansion to capacity.

Additional LAER emissions by 1990 would be 57,060 tpy because of projected new industrial growth. Considering the idle capacity of existing equipment, this figure could be as low as 49,967 tpy (57,060 - 7,093). This increase to capacity assumption (if it had been used) would only apply to the no growth scenarios analyzed for this study.

REPLACEMENT RATE

It was assumed that industrial equipment would be replaced over time because of normal wear and fatigue. The estimates of turnover time for equipment as described in Appendix D were:[1]

o Chemical industry	22 years
o Petroleum refining	32 years
o Petroleum storage and marketing	32 years

According to the present EPA emission offset policy, all process equipment which is replaced must have LAER controls applied.[2]

This study covered the 15-year period from 1975-1990. It was assumed that LAER replacements started in 1977. Thus, one would normally expect 64% (14/22) of the chemical and 44% (14/32) of the petroleum refining, storage, and marketing emissions to be replaced with LAER in the 14-year period. This represented 100,316 of the 181,710 tpy base year emissions being replaced with LAER by 1990.

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[1] Replacement rates were calculated using the EPA AQMA Guideline Procedure which suggests the use of IRS data as a base. The IRS depreciation estimates were multiplied by 2 according to the EPA methodology to arrive at the estimates for turnover.

[2] Vide, The Federal Register (to be published).

Therefore, the 100,316 tpy base year emissions would be replaced with 36,694 tpy LAER emissions by 1990, a 63,622 tpy reduction.

The estimates of the replacement rates were considered somewhat questionable because factors such as availability of feedstock or raw materials and economic factors determine when these industries rebuild, replace, or shut down. Several plants in the AQCR producing basic chemicals have been in existence since 1940.

Because these replacement rates were at best a guess of what the turnover period would be, the analyses were made first assuming no replacement at LAER and then secondly assuming rates described above. In reality, the actual number of facilities replaced with LAER will be somewhere between the bounds set by this procedure.

CHAPTER IV

ESTIMATING THE REQUIRED EMISSION REDUCTIONS

Each of the policy options discussed in the introduction will affect emission levels between now and 1990. Of paramount importance is whether the change in emissions is adequate to attain the ozone standards by no later than 1987. Of equal importance is whether reasonable further progress requirements will be met between 1979 and the attainment date. In this chapter, we discuss the current method which regulatory agencies are using to relate NMHC emissions to ozone air quality levels.

Following much study in 1978, a new standard of 0.12 ppm was established for ozone (the principle component of oxidants). This new National Ambient Air Quality Standard (NAAQS), which protects both the public health and welfare, is for a one-hour average period and is not to be exceeded more than once per year. The main thrust of this report addresses the potential for attainment of the new 0.12 ppm ozone standard; however, prior to establishing the new NAAQS, the standard for oxidants was 0.08 ppm, one-hour average. In addition, consideration was given to a new standard of 0.10 ppm during the 1978 study phase. Because of the uncertainty surrounding the level of the standard during preparation of this report, sensitivity analyses were completed assuming the NAAQS set at 0.08 and 0.10 ppm. The results of these sensitivity analyses are reported later in Chapter VI - Potential for Attaining Standard.

In order to attain the selected standard (0.12 ppm), air quality in the Houston-Galveston AQCR would have to be reduced considerably below current levels. Under the proposed EPA procedures for calculating the necessary reductions, the design on target concentration (current maximum based on 1975, 1976, and 1977 data) for the area would be 0.27 ppm (see Appendix A for definition). By just using a simple proportional relationship and a 0.27 ppm design value, one could quickly calculate that a reduction in NMHC emissions of approximately 56% will have to be achieved in order to attain a 0.12 ppm standard. More detailed methods for calculating the percent reductions are described below.

METHODS FOR RELATING OZONE TO PRECURSORS

The details of the complex process by which ozone is formed are not known; however, it is generally agreed that nonmethane hydrocarbons (NMHC) together with oxides of nitrogen (NO_x) react to form ozone in the presence of light. Hydrocarbons have been selected as the precursor requiring control because above a certain threshold proportion of NO_x, the production of ozone is more sensitive to variations in the NMHC concentration. The reduction of NMHC's is sought only in areas with significant concentrations of NO_x because it is thought that NMHC's in isolation reduce ozone concentrations by the formation of aerosols. Similarly, it is believed that NO_x in isolation deplete ozone through oxidation reactions. The degree of control of NMHC emissions required to limit ozone to specific levels, however, cannot be precisely stated and probably varies with location. Despite this, there has been a succession of increasingly sophisticated approximation techniques. Four approaches have been described by EPA as possible replacement procedures for the old Appendix J curve which was utilized in 1971 at the time of the original submittals of State Implementation Plans to EPA[1]. These are discussed briefly below.

Photochemical dispersion models have the greatest potential for evaluating the effectiveness of ozone control strategies. This potential arises primarily from the spatial and temporal resolution possible with such models and from the ability to relate emissions directly to ambient ozone concentrations as a result of chemistry and atmospheric dispersion. However, data requirements associated with models may be prohibitive in some cases. They are not generally used because (1) the data base required is generally not available; (2) extensive and expensive computational facilities are required; (3) initial and boundary conditions have to be imposed without sure knowledge; and (4) verification has been very limited.

The Empirical Kinetic Modeling Approach (EKMA) considers the chemical kinetics of a column of air transported with its ozone burden and precursor emissions downwind from an urban center. The chemical reactions predicted are based on results of smog chamber experiments with mixtures of propylene, n-butane and NO_x. Aldehydes were added to simulate automobile exhaust. Ozone resulting from irradiating various mixes was then measured and a set of isopleths was eventually developed. These related maximum afternoon concentrations of ozone downwind from a city as a function of morning concentrations of NMHC and NO_x, NMHC and NO_x emitted later, meteorological conditions, reactivity of the mix of precursors, and the concentration of ozone and precursors transported. EKMA is empirical because it requires the use of observed second high hourly ozone concentrations and morning NMHC/NO_x ratios to estimate control requirements. The EKMA reflects an effort which has been underway since December 1975 to develop a substitute for the Appendix J approach.

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[1] Uses, Limitations and Technical Basis of Procedures for Quantifying Relationships Between Photochemical Oxidants and Precursors, EPA-450/2-77-021a, U.S. Environmental Protection Agency, Research Triangle Park, N.C. November 1977.

Linear Rollback, which is even less data-intensive than EKMA, may also be a possible alternative for estimating bounds on control requirements for organic precursors. It is based on the simple but appealing assumption that the concentration of ozone achieved is directly proportional to the amount of precursor emitted. This relationship was used extensively to replace Appendix J when Appendix J fell into disuse because of its very great reduction requirements. However, Rollback's failure to consider the dependence of NMHC-ozone relationships on the prevailing NMHC/NO_x ratio during the base period limits applicability of rollback to a first order approximation. Despite the lack of scientific basis, it has been found to be in good agreement with trend data at Los Angeles.

The Modified Rollback is a fourth approach. This method is really a class of approaches which has been labeled "statistical approaches". These may employ simple regression equations, empirically derived envelope curves, stochastic models, and complex multiple regression equations. They basically assume that because they are derived from actual ambient observations they represent more closely the actual phenomenon under study, however complex. They also require the assumption that the relationships derived will apply equally well to a changed situation, regardless of the magnitude of the change, such as will exist when the required reduction is achieved. But, their use is most appropriately limited to considering moderate changes from the base control state because imposition of drastic changes could appreciably modify the functional relationship derived from the base period data.

Although the previously described ozone/precursor relationship can be applied in large urban areas, long range transport still may significantly alter control estimates in some cases. Provided transport can be measured, it can be readily incorporated into photochemical dispersion models, into EKMA, and the modified rollback approach. Transport is composed of a natural background and a manmade contribution. Natural background of ozone appears to be about 0.04 ppm, primarily from slow diffusion from the stratosphere. However, the impact of natural ozone is considerably less in urban areas due to scavenging. The impacts of naturally emitted organics and NO_x on urban ozone are probably much smaller, if not negligible.

REDUCTION REQUIRED FOR ATTAINMENT

Two estimates were made of the reduction in nonmethane hydrocarbon emissions required in the AQCR to attain the 0.12 ppm ozone standard. The two methods described above which are not data intensive and which are generally acceptable were used: EKMA and modified rollback. If one follows the recommended calculation procedure using these methods, the percentage reduction of NMHC emissions required to attain the 0.12 ppm ozone standard would be as follows (see Table IV-1 for an example of the modified rollback calculation):

Calculation Procedure	Percent Reduction
EKMA	64 (with transport)
Modified Rollback/ Statistical Procedures	59

By including transport in the EKMA calculation, consideration has been given to the unscavenged ozone transported aloft which is likely to be the component of transport having the greatest impact on maximum afternoon ozone levels observed downwind from cities. Measurements concerning transported organics are very sparse, but they indicate that these organics may be in the order of 0.1 - 0.3 ppm, with concentrations near 0.1 ppm typically found in rural areas upwind from major cities. The role of such levels would typically be to contribute about 0.01 ppm to observed maximum ozone levels near major cities. The resultant local control requirements are probably underestimated when transport is ignored in the EKMA calculation of necessary emissions reduction. The reason for the low estimate is that, in order to attain the NAAQS, local emissions would have to be reduced such that the sum of locally synthesized ozone and the combined impact of manmade and natural transported ozone is 0.12 ppm or less.

TABLE IV-1

EXAMPLE OF
MODIFIED ROLLBACK CALCULATION

$$\text{Percent Reduction} = \frac{[C-A(T_o)] - [S-A(T_f)]}{[C-A(T_o)]} \times 100$$

Where:

C = design ozone concentration (ppm)
A = additivity factor (assumed to be 0.5)
T_o = concentration of transported ozone (including natural background) associated with the design ozone concentration (ppm)
S = ozone standard (ppm)
T_f = concentration of transported ozone (including natural background) after ozone standard is attained (ppm)

Therefore:

$$\text{Percent Reduction} = \frac{[.27-.5(.10)] - [.12-.5(.06)]}{[.27-.5(.10)]} \times 100 = 59$$

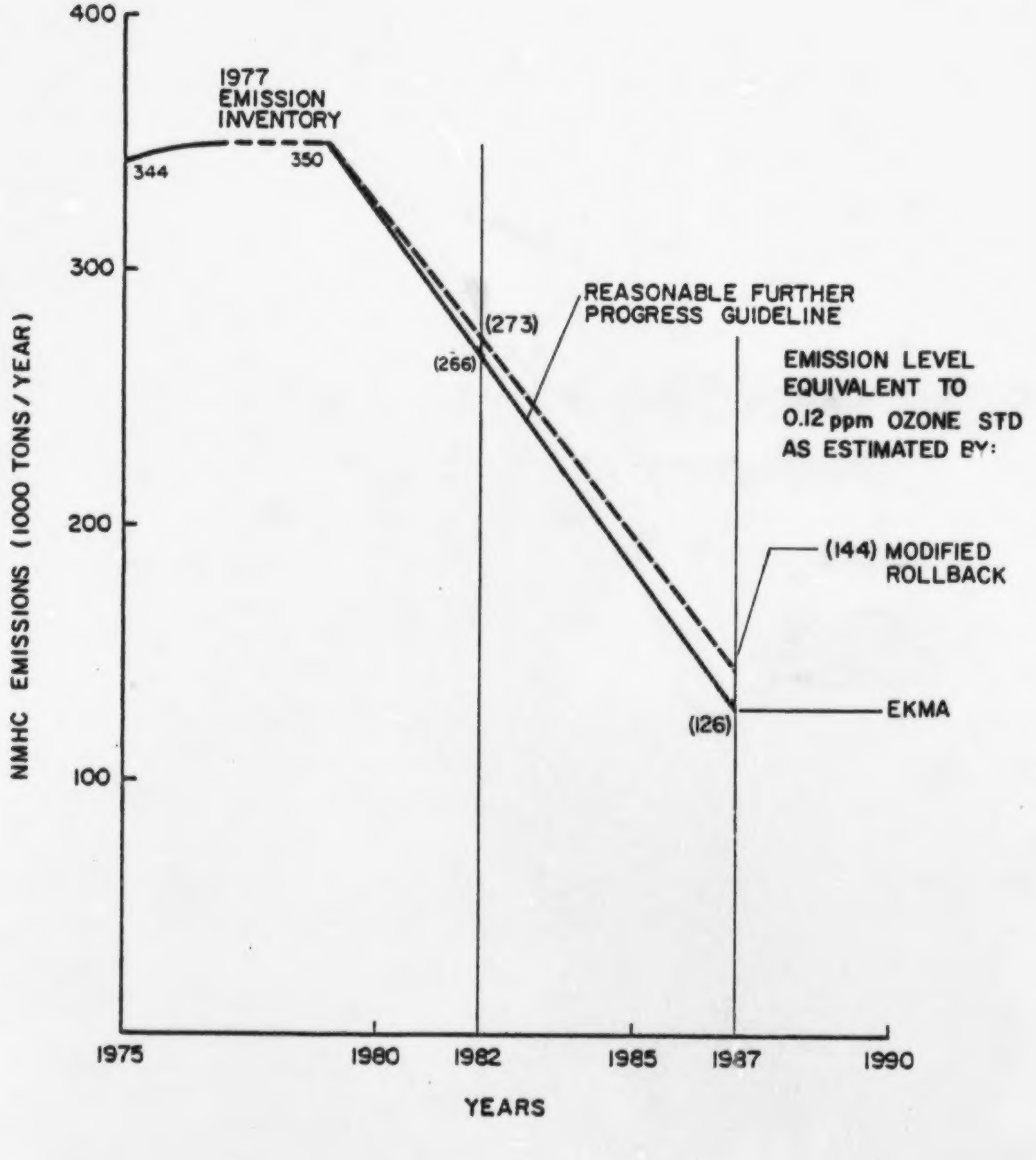
EPA believes that the scientific basis for EKMA is much stronger than for rollback. Based on theory supported through smog chamber studies, EPA's Monitoring and Data Analysis Division believes that rollback will frequently underestimate the need for NMHC reductions and that EKMA will generally provide a more reliable estimate. Unfortunately, EKMA has not yet been fully validated in field studies. For this reason and because of the current widespread use of the rollback technique, considerable latitude has been allowed to EPA's Regional Offices in accepting either EKMA or modified rollback. Both values are considered in the subsequent analysis. To calculate the 1987 emissions goal required to attain the NAAQS of 0.12 ppm ozone, the 1977 emission level of 350,040 tpy was reduced by 64% to 126,014 tpy and by 59% to 143,516 tpy reflecting EKMA and modified rollback, respectively (see Figure IV-1).

REASONABLE FURTHER PROGRESS

The Clean Air Act amendments of 1977 require that if all reasonable control measures will not bring about attainment by 1982 then attainment no later than 1987 must be guaranteed by specifying the measures which will be adopted. Furthermore, these measures must be adopted in time to demonstrate reasonable further progress (RFP). EPA defines RFP for 1982 by a linear interpolation between the 1977 emission level and the emission level required for attainment in 1987. However, the 1977 emission level is to be plotted as if it were still occurring in 1979 at the time of SIP revision approval. Ordinarily, emission levels in 1979 would be expected to be less than the 1977 emission level even though there is growth of major point, mobile, area, and minor point sources. However, the overall emissions decrease primarily because of the FMVCP. In this study, emissions in 1977 were 350,040 tpy. In 1979, the emissions were 342,703 tpy. The RFP lines defined by the EKMA and modified rollback estimates of the reduction needed for attainment are presented in Figure IV-1. To attain the 0.12 ppm ozone standard, the 1982 emissions goals using EKMA was calculated to be 266,030 tpy. Using modified rollback, the 1982 emissions goal was calculated to be 272,594 tpy.

FIGURE IV-1

REASONABLE FURTHER PROGRESS AND POTENTIAL FOR ATTAINMENT



CHAPTER V

GROWTH AND PROGRESS TOWARD ATTAINMENT (1975-1982)

In this chapter, the impact on emissions over time which would be expected from implementation of each of the policy options described in Chapter I are analyzed. Analyses were conducted for the period 1975 through 1990 and the discussion in this chapter centers around the Clean Air Act's "reasonable further progress" (RFP) requirement in 1982. Presumably, the TACB will be submitting a "two stage SIP" because it is extremely doubtful that attainment in 1982 can be realized. Workshops presented by EPA have indicated that by 1982 each state must show that its overall emission reduction program is on schedule. For this study, base year emissions in all source categories were augmented or reduced according to growth and control technology changes dictated by each policy option. Emissions during the years 1979, 1980, and 1981 reportedly are not critical as long as emissions do not increase above the 1979 level. In a subsequent chapter, each of the policy options is examined for its potential for ensuring attainment with the 0.12 ppm ozone standard by December 31, 1987 as required by the Clean Air Act Amendments of 1977. It was assumed that none of the examined policies could be fully implemented and in effect until 1980. Therefore, the emission levels for the policies analyzed were assumed to be the same for the period 1975 through 1979. The levels deviate after 1979 and this deviation is examined below to determine whether the emission reduction achieved meets the criteria for RFP derived in Chapter IV.

I: PRE-1979 SIP WITH MAJOR SOURCE CONSTRUCTION

An analysis was made of emission levels assuming that the pre-1979 SIP would remain in effect through the year 1990. It was further assumed that existing permitting procedures used by the TACB would also remain in effect over this period. Under these TACB procedures, all new expansions would require LAER technology. The EPA offset policy was assumed to be in effect requiring 1:1 offsets for major source growth in 1977 through 1979; but, no emission offset policy was assumed to be in effect after 1979. Under this scenario, no emission reductions were required for existing major sources. Area and minor stationary sources were assumed to grow, but have no more controls than in the base year 1975. Mobile source emissions were assumed to grow without a transportation control plan and without any inspection and maintenance program.

This particular scenario was not a policy option that was being considered by EPA, but rather reflected the change in emissions and resultant air quality if there were no SIP revisions. Reductions in emissions resulted only because of the Federal Motor Vehicle Control Program (FMVCP).

Major point sources were allowed to grow using LAER controls as required by the TACB regulations. Using estimates of growth for each industrial process in the AQCR, it was determined that 21,754 tpy additional LAER emissions would have to be added to accommodate all projected major source growth in the AQCR by 1982. During the period 1977-1979, offsets eliminated 8,598 tpy. Total major point source emissions in 1982 were 194,866 tpy assuming no replacement of existing equipment with LAER. In this scenario, no increase was assumed for expansion to plant capacity from the base year of 1975 because all growth was accommodated under this particular scenario in new plants.

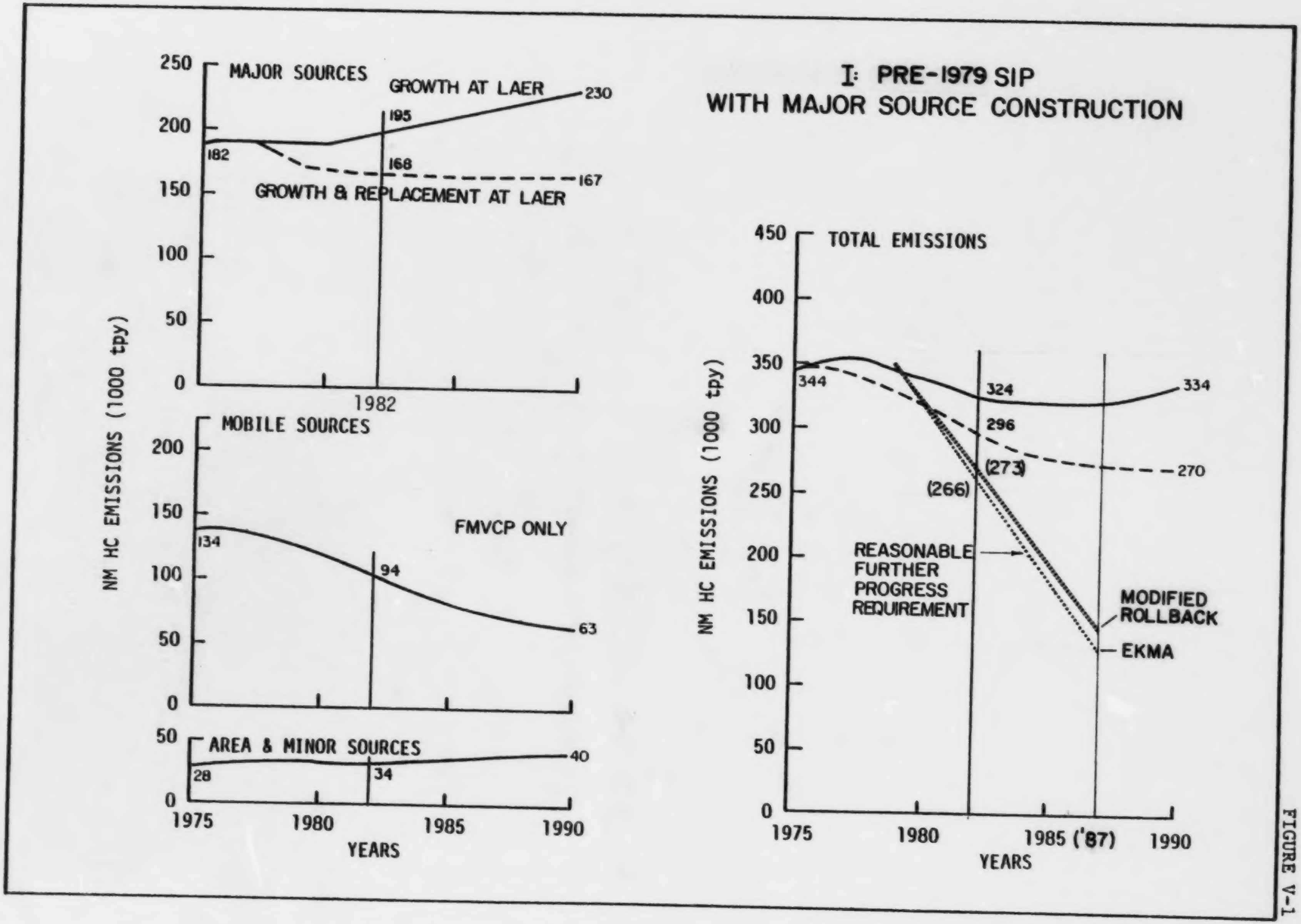
The estimates for process and control equipment replacements described in Chapter III reflect a rapid turnover in process equipment. The two lines shown under major sources in Figure V-1 are certain to "bound" the probable rate of replacement and, indirectly, the emission rate under this base case in 1982. Under the replacement scenario, major source emissions would be 167,599 tpy by 1982.

Mobile source emissions were projected to decrease from 134,381 tpy in 1975 to 94,463 tpy in 1982, a 30% reduction. Although vehicle miles traveled (VMT) increased during the period, emissions decreased due to the FMVCP. Area and minor source emissions increased 23% to 34,251 tpy in 1982 .

Under this scenario, total emissions were projected to be 323,580 tpy in 1982 compared to the 266,030 and 272,594 tpy emission levels required to demonstrate RFP by the EKMA and modified rollback guides, respectively (see Figure V-1). When all growth of major point, mobile, area, and minor point sources is included to this option, it is obvious that additional control measures would have to be developed in order to meet the RFP requirement of the Clean Air Act.

II: RACT SIP WITH MAJOR SOURCE CONSTRUCTION

An analysis was made of NMHC emissions assuming that all existing sources were controlled to RACT levels. The emission offset policy was assumed to be



I: PRE-1979 SIP
WITH MAJOR SOURCE CONSTRUCTION

in effect between 1977 and 1979. All new major source growth met the LAER control technology requirements. Controls at RACT were also assumed for area sources and minor sources. Mobile source emissions were assumed to be controlled below the FMVCP through the use of a strong I/M program. Strong, in this study, implied a 30% stringency factor and a mechanics training program. Figure V-2 illustrates the emission trends from 1975 through 1990 for major point, mobile, area, minor point, and total emissions.

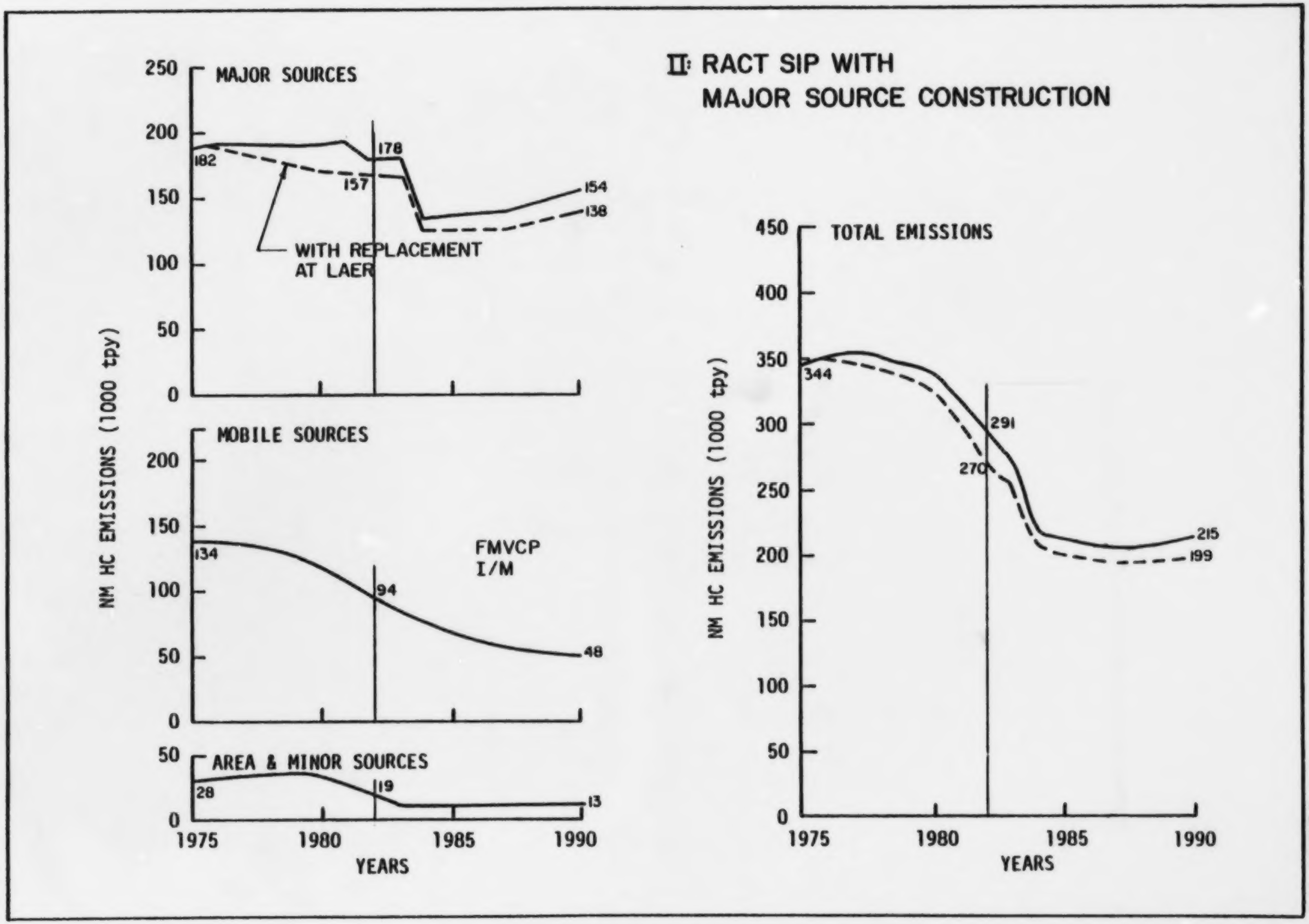
Major point source emissions decreased substantially in 1982 and 1984 as a result of compliance with the RACT SIP. Major point source emissions were reduced from 181,710 to 178,183 tpy between year end 1975 and 1982.

The schedule under which RACT controls would be implemented for the 200 different industrial processes located in the Houston-Galveston area first was determined by the schedule of the initial EPA Guidance documents and a compliance schedule which gives industry 2 to 5 years to meet the new regulations (Appendix C, Table C-1). The EPA has adopted a position which would permit states to phase-in the RACT hydrocarbon control requirement over the period 1979-1982 following issuance of EPA guidance. At the time of this study, about 15 control technology guideline (CTG) documents had been issued by EPA. About 185 remaining ones are supposed to be issued within the next two years. Full compliance with all of these guidelines is estimated to occur either by 1982, 1984, or, in some cases, as late as 1986.

In order to demonstrate sufficient progress in 1982 for this particular policy option, an accelerated RACT schedule would have to be developed. If all of the source categories presently scheduled to comply with new RACT regulations by December 31, 1983 were adopted and brought into compliance by 1982, the RFP requirement as determined by either EKMA or modified rollback would more than be achieved. Under this accelerated RACT adoption case, emissions would be 231,967 tpy by the end of the calendar year 1982. From a review of the major emission categories for point sources (Table V-1), it would appear that schedules for four key processes would have to be accelerated in order to meet the RFP requirement of 1982 and provide for all of the anticipated emissions growth. However, accelerating RACT regulations and actual implementation of the controls on existing industrial processes may be difficult.

The effect of an I/M program in reducing mobile source emissions does not show up, because of its implementation schedule, until 1983. Area and

FIGURE V-2



II: RACT SIP WITH MAJOR SOURCE CONSTRUCTION

TABLE V-1

POTENTIAL CATEGORIES FOR ACCELERATED RACT CONTROLS

CATEGORY	POTENTIAL REDUCTION (TONS/YEAR)	CURRENT ESTIMATE OF TIME NECESSARY TO COMPLY (YEARS)
Carbon Black	8,977	4
Butadiene - Synthetic Rubber	5,273	4
Low Density Polyethylene	3,405	4
Ethylene Dichloride	1,746	4
Ethylene	1,551	4
Olefins	942	4
Subtotal	21,894	
Petroleum Refining Fugitives	9,812	5
Cooling Towers	952	5
Total	32,658	

minor source emissions decrease from 27,860 tpy in 1975 to 18,525 as a result of the RACT SIP being implemented for several area source categories.

The RFP guideline necessary to demonstrate attainment is shown in Figure V-3. Emission levels of 266,030 or 272,594 tpy would have to be achieved in 1982 in order to meet the EKMA or modified rollback requirements, respectively. Under this policy option, emissions were 291,171 tpy for a RACT SIP with major source construction at LAER and 269,888 tpy for the same case, but with LAER replacement of existing control technology.

III: RACT SIP WITH OFFSETS FOR NEW MAJOR SOURCE CONSTRUCTION

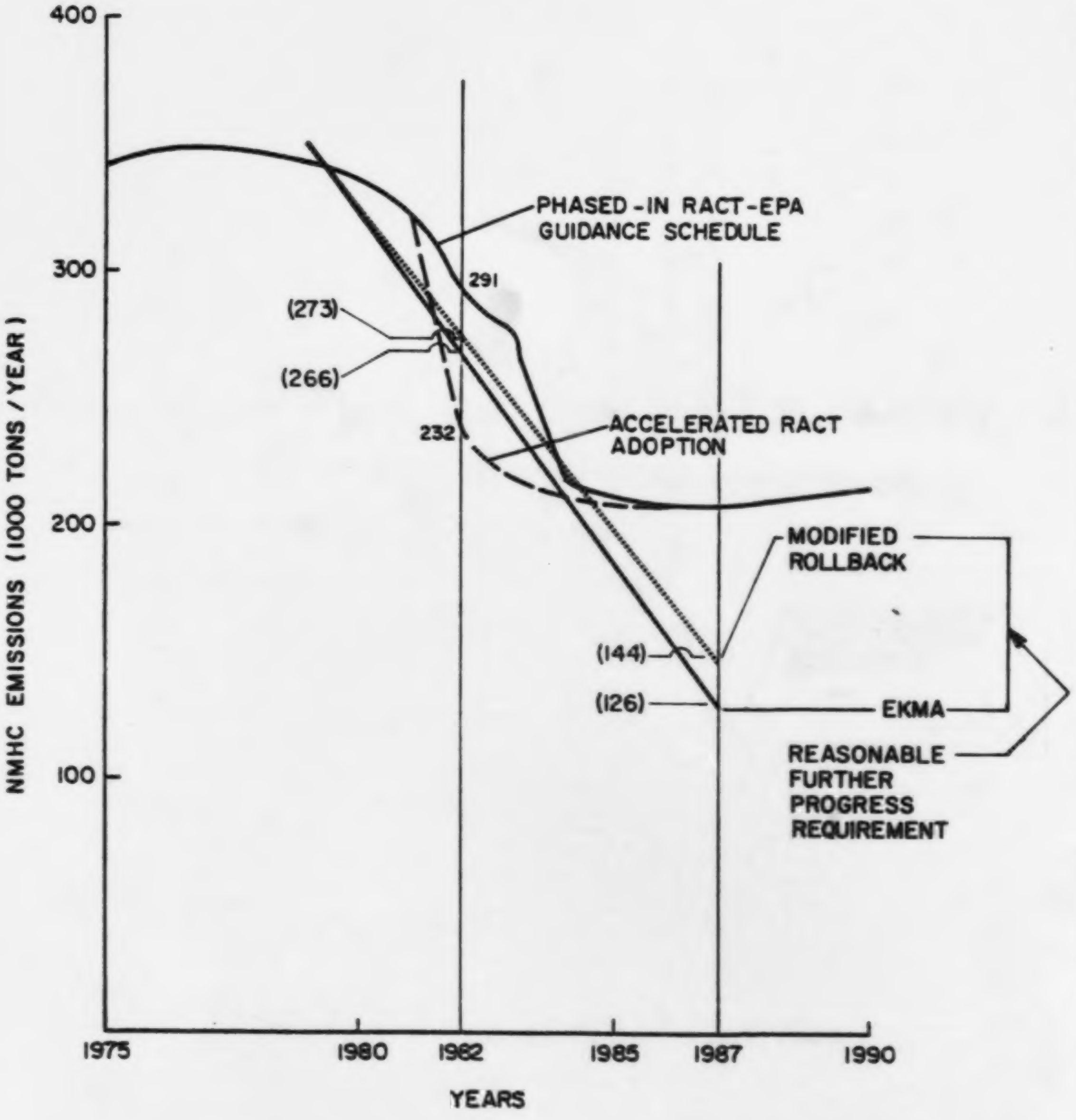
In nonattainment areas, new major source growth can be accommodated if either the SIP revision requires sufficient emission reduction from existing sources for such growth or if an emission offset program is established. The potential effect of an emissions offset policy is analyzed in this policy option. New sources were assumed to require offsets from 1977 to 1979 in accordance with the existing EPA offset policy; in the following years, 1980 to 1990, the SIP revision was assumed to provide for emission offsets. For all new major source construction in this period, the new source emissions at LAER levels had to be offset by at least an equal amount from existing sources. The offset ratio can be varied, so a 1:1 ratio and a 3:1 ratio were considered here.

For this scenario, offsets required for major new source growth were accommodated by applying RACT controls to the existing inventory. However, the SIP would eradicate many of the potential offsets that were available as regulations are phased-in in 1979, 1980, and finally, 1981. These reductions expected from the SIP revisions could be used as offsets in the early years until a RACT SIP was completely in place. (As soon as RACT controls become part of the SIP, they are no longer available as offsets.) If there were delays by EPA in issuing the CTG's, there could be a corresponding time delay in emission reductions from major sources and possibly fewer emission reductions by 1987 or 1990 because these reductions could be used as offsets. After RACT offsets are used up, demand for additional offsets will drive replacement rates or retrofit to LAER or beyond.

Area and minor point sources were controlled to RACT levels while mobile sources were controlled through the FMVCP and a strong I/M program.

FIGURE V-3

II: RACT SIP WITH MAJOR SOURCE CONSTRUCTION



1:1 Offset Ratio

Table V-2 illustrates the emissions analysis considering growth and offsets for major point sources from 1976 through 1990. The table summarizes the emissions and the additional growth expected for each year as well as the number of offsets that are available for each year. From time to time, SIP amendments will eradicate RACT-type offsets (Table V-3).

The information contained in the tables was used to plot the time series analyses shown in Figure V-4. Emissions decreased by 50% from 1975 through 1990 to an emission level of 172,764 tpy. The figure shows a slight increase in major point source emissions from year end 1975 to 1976. The offset policy was assumed not to be in effect during this period. From year end 1976 through 1981, point source emissions remained constant. This is because all new emissions must be offset by an equal amount of existing emissions. A decrease is noted in 1982 because many sources are then scheduled to comply with the new SIP. Growth occurs during this period; however, there is an overall emission reduction. A similar reduction occurs in 1984 representing compliance with the second phase of control technology guidelines issued by EPA. Ordinarily, a third reduction in major sources would be expected; however, this reduction has been eliminated because RACT-type offsets were used to accomodate growth in the period 1976 through 1982. Thus, no decrease is observed in 1986 even though compliance with the new SIP was expected of some sources. A slight increase (3,352 tpy) occurs in 1988 for the major source category because the offsets are obtained from area sources.

All projected growth can be accommodated through 1987 and almost all major source growth (81% of that projected to occur) can be accommodated through 1990 with current control technology assumptions used in the study. Beginning in 1981, major point sources must obtain LAER offsets. These are the offsets that are obtained by going from RACT to LAER on existing sources. That is, sources were assumed to reduce emissions from current to RACT over the next two years and then further reduce emissions to LAER beginning in 1981. Given the expense of retrofitting twice (from current RACT and then RACT to LAER), this assumption is unlikely. In 1988, additional growth may eventually be curtailed if sources cannot achieve further reduction beyond LAER offsets available from either point sources or area sources. In other words, area and point sources are controlled to the lowest possible levels as currently

TABLE V-2

EMISSIONS ANALYSIS OF MAJOR SOURCES[a)] (tons/year NMHC)

ANALYSIS	OFFSETS AVAILABLE (OFFSET RATIO 1:1)
1976 181,710 base year 1975 emissions + 2,866 growth - 0 (no offsets required) 184,576	(not applicable)
1977 - 1979 184,576 at end of 1976 + 8,598 growth - 8,598 offsets 184,576	84,475 available - 8,598 offsets used 75,877 - 24,811 SIP decrease 51,066 remaining RACT offsets
1980 184,576 at end of 1979 + 2,866 growth - 2,866 184,576	51,066 available - 2,866 offsets used 48,200 - 48,200 SIP decrease (required 53,948) 0 remaining RACT offsets
1981 184,576 at end of 1980 + 3,712 growth - 3,712 offsets - 0 compliance with new SIP 184,576	28,708 LAER offsets - 3,712 offsets used 24,996 remaining LAER offsets
1982 184,576 at end of 1981 + 3,712 growth - 3,712 offsets - 14,047 compliance with new SIP* 170,529	24,996 - 3,712 offsets used 21,284 remaining LAER offsets

a) Growth and offsets assumed to occur in the same year.

TABLE V-2 (CONT'D.)

EMISSIONS ANALYSIS OF MAJOR SOURCES[a)] (tons/year NMHC)

ANALYSIS	OFFSETS AVAILABLE (OFFSET RATIO 1:1)
1983	
170,529	
+ 3,712 growth	21,284
- 3,712 offsets	- 3,712 offsets used
- 0 compliance with new SIP	17,572 remaining LAER offsets
170,529	
1984	
170,529	
+ 3,712 growth	17,572
- 3,712 offsets	- 3,712 offsets used
- 58,964 compliance with new SIP	13,860 remaining LAER offsets
111,565	
1985	
111,565	
+ 3,712 growth	13,860
- 3,712 offsets	- 3,712 offsets used
- 0 compliance with new SIP	10,148 remaining LAER offsets
111,565	
1986	
111,565	
+ 4,834 growth	10,148
- 4,834 offsets	- 4,834 offsets used
- 0 compliance with new SIP	5,314 remaining LAER offsets
111,565	
1987	
111,565	
+ 4,834 growth	5,314
- 4,834 offsets	- 4,834 offsets used
- 0 compliance with new SIP	480 remaining LAER offsets
111,565	

TABLE V-2 (CONT'D.)

EMISSIONS ANALYSIS OF MAJOR SOURCES[a] (tons/year NMHC)

ANALYSIS	OFFSETS AVAILABLE (OFFSET RATIO 1:1)
1988 111,565 + 3,832 growth (required 4,834) - 480 (+ 3,352 area sources) 0 compliance with new SIP 114,917	480 - 480 offsets used 0 remaining LAER offsets from point sources 3,352 1990 RACT to RACT-2 offsets from area sources - 3,352 offsets used 0 remaining area source RACT-2 offsets
1989 114,917 + 0 growth (4,834 required) - 0 offsets 114,917	** Growth curtailed unless new control approaches are developed.
1990 114,917 + 0 growth (4,834 required) - 0 offsets 114,917	

---

* By complying with the new SIP, emissions were reduced by 14,047 tpy in 1982 and 58,964 tpy in 1984. These emissions coupled with the emissions used as offsets from 1977 - 1980 equal 84,475 tpy (14,047 + 58,964 + 8,598 + 2,866).

** Total growth between 1975 and 1990 was 46,390 tpy under this scenario. In order to accommodate all of the 57,060 tpy growth predicted for this period, better controls will have to be developed.

TABLE V-3

AVAILABLE NMHC OFFSETS[a]

YEAR	POTENTIAL OFFSETS[b] MAJOR POINT SOURCES	DECREASE DUE TO SIP
1979	84,475[d]	36,045
1980	59,664	42,714
1981	5,716	3,318
1982	2,398	2,398
1983-1990		
RACT to LAER Offsets[c]	28,708	none
		TOTAL 84,475

[a] In addition to these offsets from point sources, there are 19,129 tpy of area source offsets (Actual to RACT). However, all of these potential offsets are eradicated by the SIP by 1980.

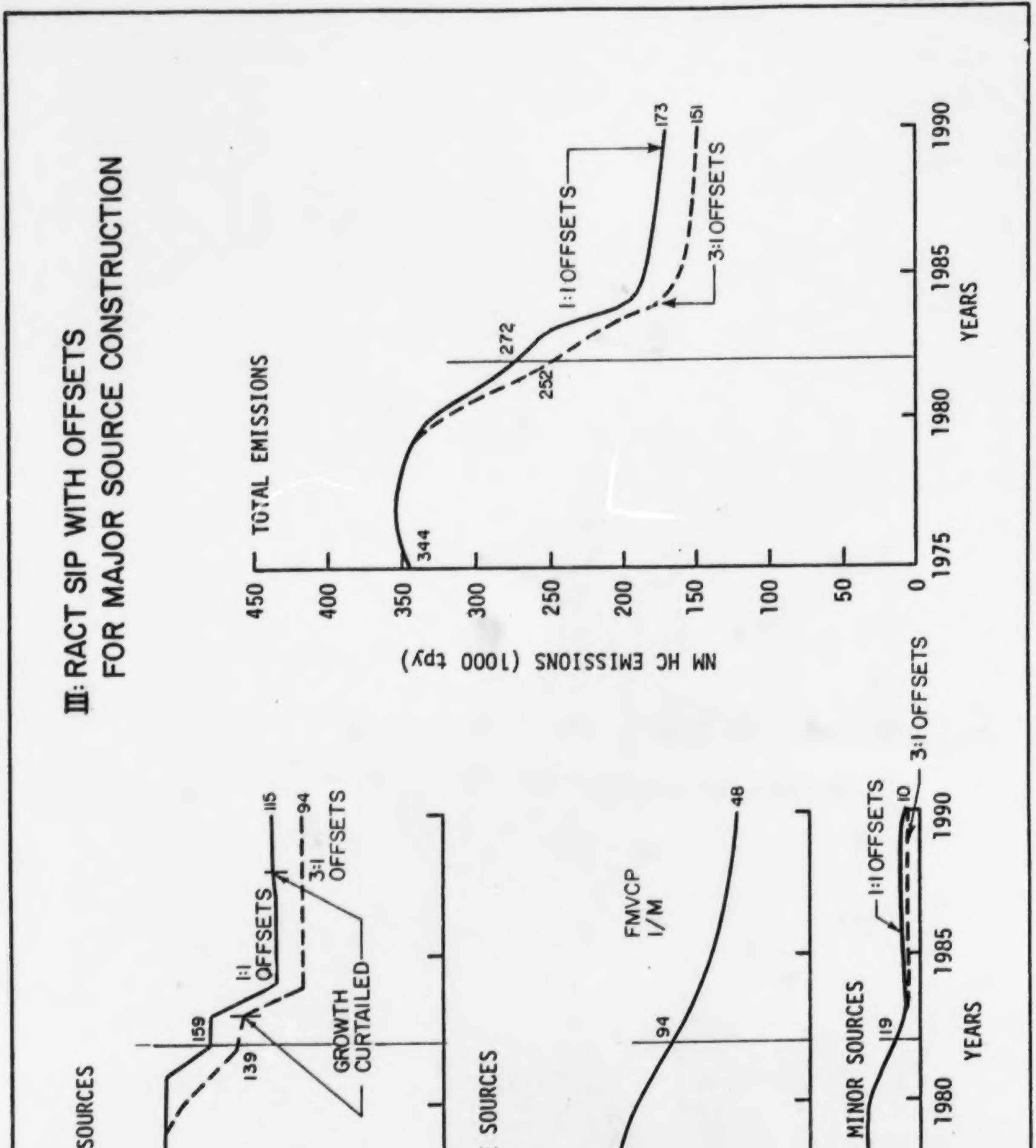
[b] The potential offsets reflect the controls of major point sources placed on existing equipment.

[c] Additional offsets can be achieved if old process equipment is replaced and LAER controls are used. The additional offsets are 28,708 tons/year (available for any period). In this analysis, we assumed that the decreases would occur after 1982 because the SIP will have eradicated other potential offsets.

[d] Actual 1975 emissions of 181,710 minus 97,235 RACT 1975 emissions equal 84,475 tons per year.

EMISSION REDUCTION AS A RESULT OF COMPLYING WITH A NEW RACT SIP

YEAR	BASE EMISSIONS REDUCED (tons/year)
1982	25,281
1984	53,478
1986	5,716
	84,475



III: RACT SIP WITH OFFSETS FOR MAJOR SOURCE CONSTRUCTION defined. Whether or not it is possible for existing sources to be retrofitted to LAER controls was not a consideration in this analysis. If offsets beyond RACT levels approaching LAER were not obtainable, growth would be curtailed in 1983 and only 20% of the projected growth could occur.

Overall there are substantial reductions in total emissions taking place from 1979 to 1982. The emission reductions shown result from the application of better controls to existing sources. Better control technology for new sources is not of prime importance in reducing overall emissions. Rather, improvements in LAER will maximize the economic growth that could be accommodated for a specified quantity of offsets and may achieve reductions in emissions whenever existing sources are replaced. But on balance, the reductions achievable from existing sources are of paramount importance in order to achieve standards. Therefore, in order to attain the standards in the Houston-Galveston area, it will be necessary to develop better technology for existing sources. One might expect the progression from RACT to LAER levels to accomplish this.

3:1 Offset Ratio

This policy option is identical to the one described above, except that the emission offset ratio was set at 3:1. Thus, for every ton per year of new source growth that was added, a net benefit of two tons would result. The assumptions for minor point, area, and mobile sources described above also were assumed for this scenario. Emissions decreased by 56% from the base year 1975 to an emission level of 151,390 tpy in 1990 (see Figure V-4).

For this analysis, it was assumed that the 3:1 ratio was initiated after 1979. In this scenario, the RACT SIP did not have a chance to decrease existing emissions by itself. This was because the growth demand for the area and the required offsets occurred much faster than the SIP could decrease existing emissions. Because demand for offsets was greater under this scenario, growth would be curtailed in 1983 unless additional controls could be found beyond those assumed in this study. At that time, all existing and new sources would be controlled to the lowest possible level. Area sources would also be controlled to RACT-2 levels. Emissions are about 20,000 tpy lower under this higher offset scenario than udner the 1:1 offset scenario previously analyzed. The higher offset ratio allows only 44% (25,016/57,060) of the projected growth to occur with control levels as defined in this study. Much more advanced technology for controlling pollution would have to be developed for existing and new sources in order to accommodate more growth under this scenario.

Reasonable Further Progress Requirement

With a 1:1 offset ratio and the EPA CTG schedule, the 1982 NMHC emissions would be 272,283 tpy, which is just sufficient to meet the 272,594 tpy level required by modified rollback to demonstrate RFP, but not sufficient to meet the 266,030 EKMA requirement. However, if an accelerated RACT schedule were developed for just one emission category (e.g., carbon black manufacturing, 9,000 tpy), then the 1982 EKMA goal could be achieved (272,283 - 9,000 = 263,283 tpy vis-a-vis the 266,030 tpy). Under the 3:1 offset ratio, the emission levels in 1982 were 251,703 tpy, which easily meets both the EKMA and modified rollback RFP requirement (see Figure V-5 for each offset ratio).

IV: RACT SIP WITH NO MAJOR SOURCE CONSTRUCTION AFTER 1979

In this policy option, emission levels in the AQCR were analyzed assuming all existing sources controlled their emissions to RACT levels and no new major source construction was allowed. The RACT SIP revisions were assumed to be adopted and complied with according to the EPA's CTG schedule discussed previously. Area sources were controlled at the RACT level and compliance with the 1979 SIP revision was required by 1982. Mobile sources were controlled through the FMVCP supplemented by a strong I/M program beginning in 1980. Minor source growth took place at RACT and existing minor sources were required to comply with the RACT SIP revisions also.

Substantial emission reductions occurred between 1979 and 1982 under this policy option (see Figure V-6). The 1982 emission level was 272,383, just slightly below the level required to meet the modified rollback RFP requirement, but above the EKMA RFP requirement. When LAER technology was assumed to replace controls on existing sources, emissions were 259,598 tpy which more than meets both requirements.

By comparison, an emission offset policy was as effective in reducing emissions as a no-growth policy on major new sources in the period from 1975 through 1983. The 1982 emissions were identical for both policies because offsets were available and were used during the period 1979 through 1982.

III: RACT SIP WITH OFFSETS FOR MAJOR SOURCE CONSTRUCTION

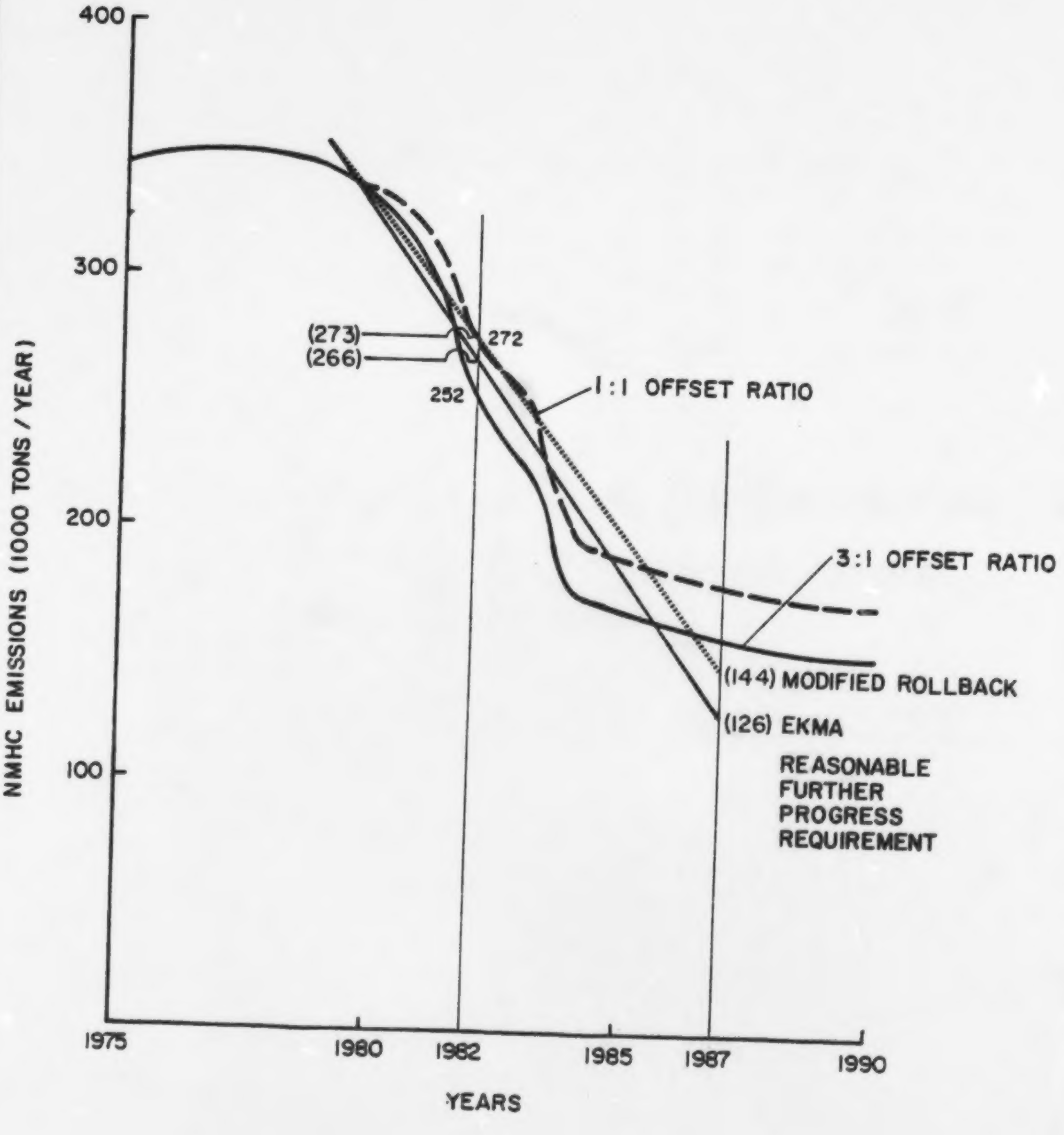
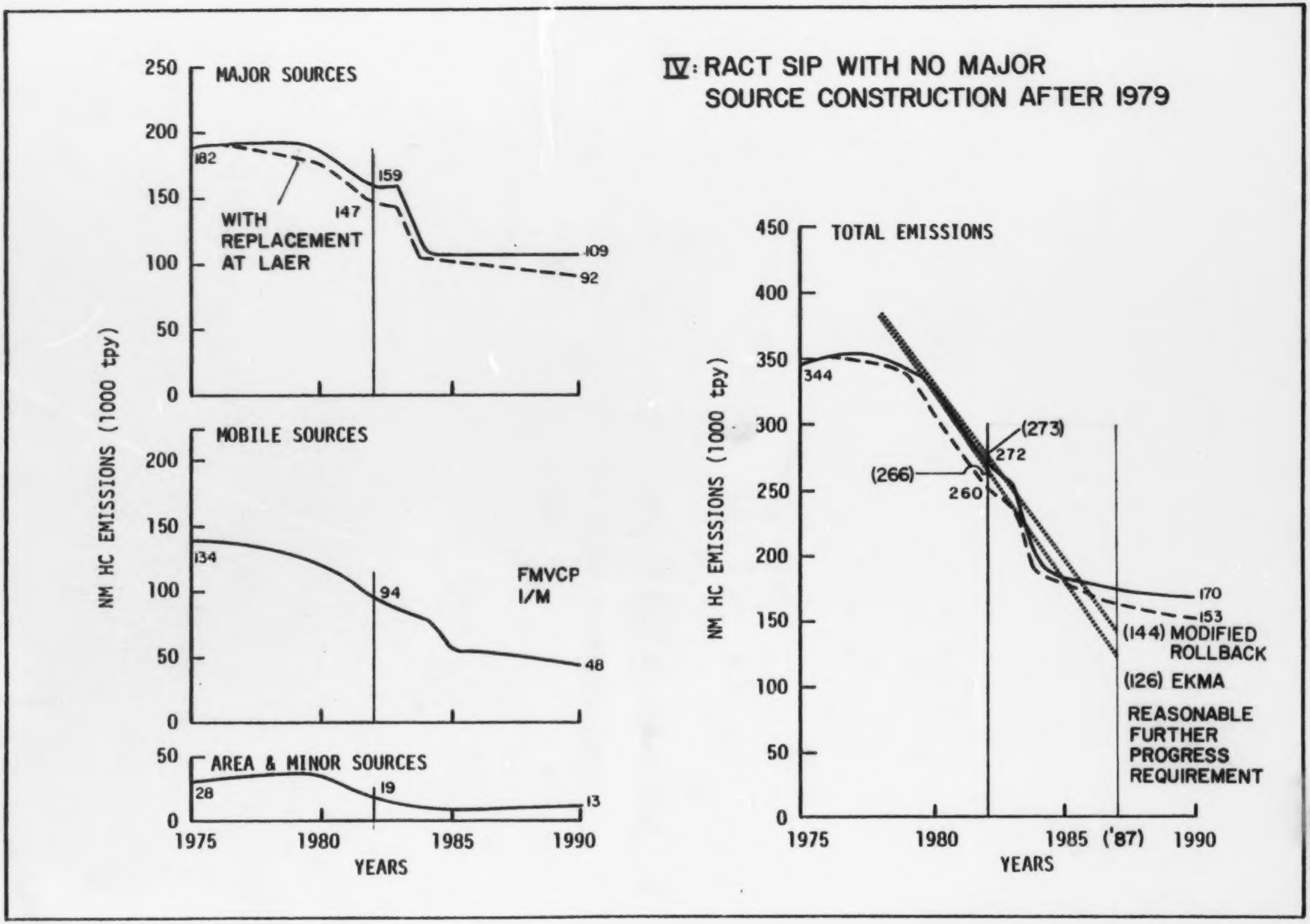


FIGURE V-6



IV: RACT SIP WITH NO MAJOR SOURCE CONSTRUCTION AFTER 1979

V: LAER REPLACEMENT WITH NO MAJOR SOURCE CONSTRUCTION AFTER 1979

This policy option was devised as a theoretical "best case" to determine emission levels if the entire economic base were replaced by 1990 using the best control for new sources. In this option, it was assumed that the only industrial growth permitted in the AQCR was that due to replacement of existing capacity potentially lost due to retirement and this occurred within the study period. Furthermore, it was assumed that sources being replaced would use LAER control technology. Presumably, the emission levels achievable with replacement of existing capacity by LAER controls were the best that could be expected with current technology in the Houston-Galveston area. No new plants were assumed to locate in the study area and no increases in capacity were assumed.

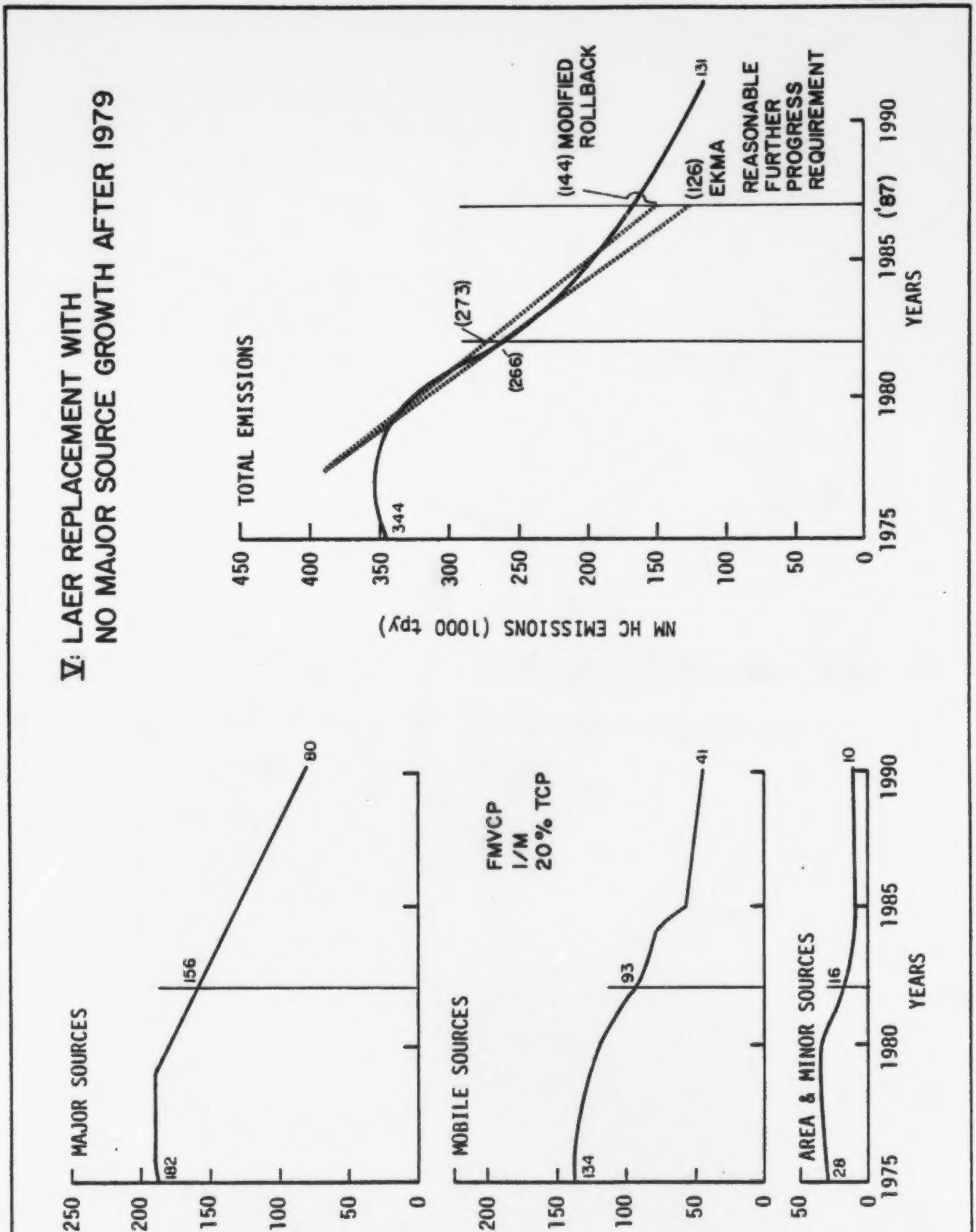
Retirement schedules for the types of major industry located in the AQCR were generated largely from IRS data. Baesd on these data (Appendix D), it was expected that all of the industry which emits hydrocarbons in the Houston-Galveston area would be completely replaced by about the year 2020. Such estimates for productive life of specific equipment were developed for tax purposes and did not necessarily reflect realistic lifetimes of process equipment. For example, some plants currently operating in the Houston-Galveston area had been in existence for more than 35 years, already some 17 years longer than IRS data suggested as their useful life.

It was very questionable whether LAER-type controls could physically be applied/retrofitted to all existing sources. Furthermore, because of the economic considerations, such a policy would probably inhibit replacements. Even though these considerations were recognized, the IRS replacement rate was still assumed to occur between 1979 and 1990 for all major sources.

Area sources were assumed to grow and be controlled to the RACT-2 level. Mobile sources were also assumed to grow. A strong I/M program was assumed to be in effect; in addition, a 20% reduction in VMT through the use of a transportation control plan was assumed. Indeed, the assumptions regarding emission control for major point, area, minor point, and mobile sources were the most stringent of all policy options considered in this study.

Under this scenario, major point source emissions were reduced from 181,710 to 156,000 tpy by 1982 (see Figure V-7). The 1982 emissions from all

FIGURE V-7


V: LAER REPLACEMENT WITH
NO MAJOR SOURCE GROWTH AFTER 1979
MAJOR SOURCES
182
156
80
MOBILE SOURCES
134
93
41
FMVCP
I/M
20% TCP
AREA & MINOR SOURCES
28
16
10
NM HC EMISSIONS (1000 tpy)
250
200
150
100
50
0
1975
1980
1985
1990
YEARS
TOTAL EMISSIONS
344
(273)
(266)
(144) MODIFIED ROLLBACK
(126) EKMA
131
REASONABLE FURTHER PROGRESS REQUIREMENT
('87)
450
400
350
300

sources were 265,820 tpy, which is well below the level required to meet the modified rollback RFP requirement and just slightly below the EKMA RFP requirement.

COMPARISON OF PROJECTED EMISSIONS

Table V-4 summarizes the RFP emissions expected from each of the policy options analyzed in this chapter. The RFP emission requirement in 1982 to move toward the 0.12 ppm ozone standard was 266,030 tpy based on EKMA and 272,594 tpy based on modified rollback. The 1982 emission levels required for other ozone standards are also summarized in the table.

Timely adoption of new regulations and compliance by several key industrial processes, such as those listed in Table V-1, would have to occur in order to meet both RFP requirements under the policy option of a RACT SIP and a continuing 3:1 offset policy for construction of major new sources. Replacement of controls on existing major sources with LAER technology, while somewhat theoretical, would have a significant benefit on achieving the RFP requirement. As pointed out in a previous chapter, the emission limit was somewhat sensitive to the ozone standard, it therefore follows that the impact of the policy options was affected by changing the ozone standard in the range of 0.08 to 0.12 ppm. The no growth policy options and the 3:1 offset ratio option (which also limits growth) would allow the study area to meet the 1982 emission level required to demonstrate RFP.

TABLE V-4

COMPARISON OF PROJECTED EMISSIONS WITH THE REASONABLE FURTHER PROGRESS REQUIREMENT UNDER VARIOUS POLICY OPTIONS

SCENARIOS	PROJECTED 1982 EMISSIONS[a,b] (tpy)	FURTHER REDUCTIONS REQUIRED (tpy)	
		EKMA	MODIFIED ROLLBACK
Base Case: Pre-1979 SIP with Major Source Construction[c]	323,580	57,550	50,986
- with replacements at LAER	296,313	30,283	23,719
RACT SIP with Major Source Construction	291,171	25,141	18,577
- with replacements at LAER	269,888	3,858	0
RACT SIP with Offsets for Major Source Construction			
- 1:1 offset ratio	272,283	6,253	0
- 3:1 offset ratio	251,703	0	0
RACT SIP with No Major Source Construction after 1979	272,283	6,253	0
- with replacements at LAER	259,598	0	0
LAER Replacement with No Major Source Construction after 1979	265,820	0	0

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[a] Represents the current schedule for phasing-in RACT SIP adoption over the period 1979-1982 and compliance over the period 1981-1986.

[b] Reasonable further progress requirements in 1982:

Oxidant Standard		1982 Emission Level (tpy) EKMA	1982 Emission Level (tpy) Modified Rollback
Old Standard	0.08 ppm	254,217	248,966
Alternate Standard	0.10 ppm	259,467	260,780
New Standard	0.12 ppm	266,030	272,594

CHAPTER VI

POTENTIAL FOR ATTAINING STANDARDS

In Chapter IV, the reduction in nonmethane hydrocarbon (NMHC) emissions required to attain the 0.12 ppm ozone standard was calculated. Two methods were used: modified rollback, which has some empirical support but no theoretical basis, and EKMA, which is a procedure that relies partly on empiricism and partly on theoretical grounds. Rollback estimates indicate that a 59% reduction will result in attainment; EKMA estimates are more conservative and require a 64% reduction. Applying these figures to the initial emission inventory, we arrive at the range of emissions equivalent to the 0.12 ppm standard: 126,014 to 143,516 tpy. In this chapter, the potential emission reductions achieved by the policy options studied are considered at the statutory time limit, December 31, 1987. The question of attainment is focal. Then, the reliability of results is tested by considering their sensitivity to variations in assumptions and values assigned to basic parameters.

POTENTIAL FOR ATTAINMENT

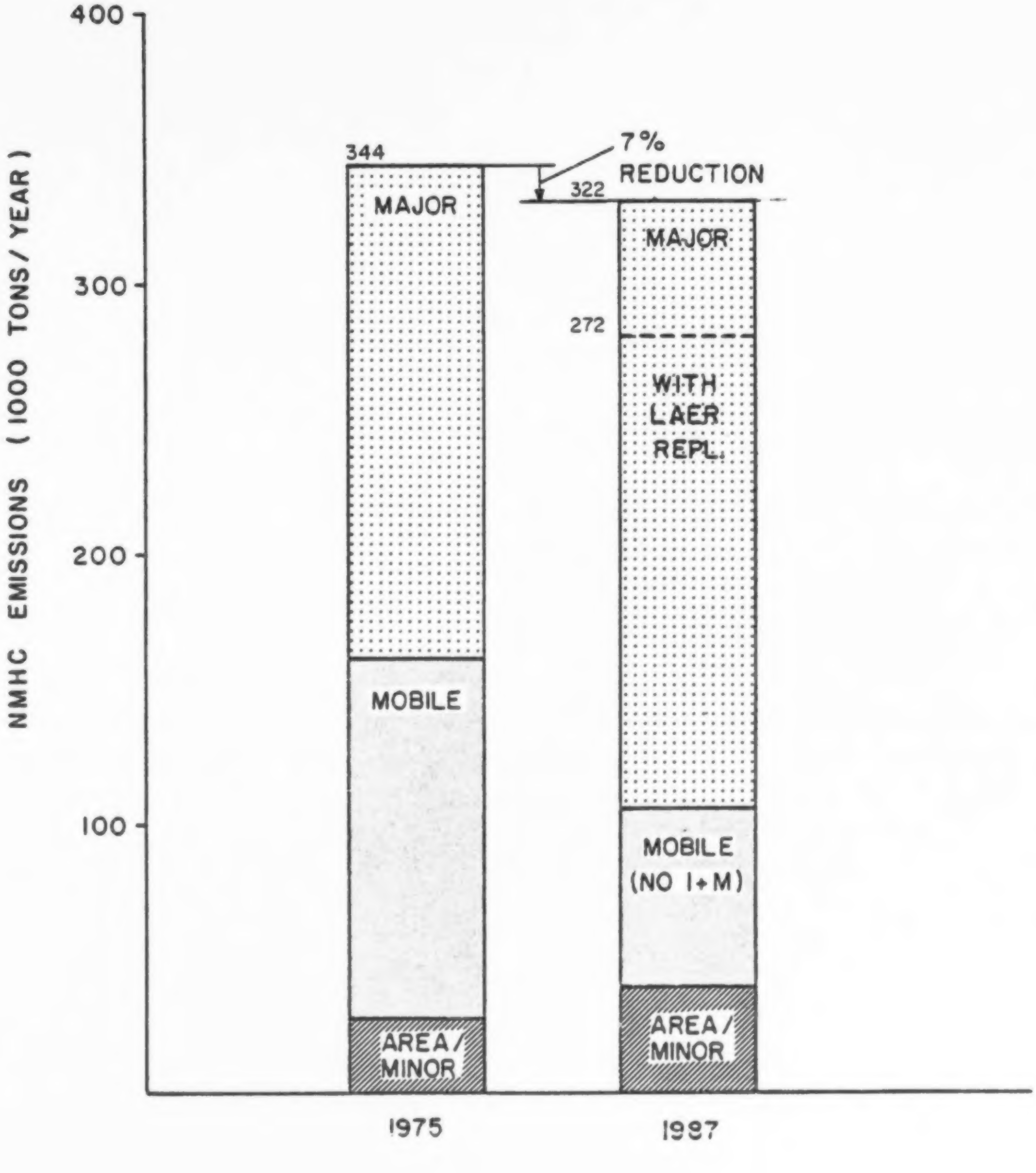
I: Pre-1979 SIP With Major Source Construction

This policy represented the worst case situation for air quality and emissions; it was examined to illustrate the change in emissions if nothing were done to change regulations or control pollution sources more stringently. Total emissions in 1987, under this scenario, were estimated at 321,578 tpy compared to 344,000 tpy in 1975. The minimum required goal to just attain the new 0.12 ppm ozone standard would be less than 143,516 tpy. Assuming the IRS turnover rates for industry and that old equipment is replaced with LAER, the 1987 emission level would be 271,594 tpy (see Figure VI-1).

Under this policy option, major point source emissions increased from 181,710 tpy in 1975 to 215,560 tpy in 1987 (17%) while mobile source emissions decreased by 50% from 134,381 tpy in 1975 to 67,852 tpy in 1987. This decrease was projected as a result of the Federal Motor Vehicle Control Program (FMVCP). Area and minor source emissions increased by about 10,000 tpy from 1975 to 1987.

FIGURE VI-1

I: BASE CASE **PRE-1979** SIP WITH MAJOR SOURCE CONSTRUCTION



II: RACT SIP With Major Source Construction

The RACT SIP brings about emission reductions in three ways:

- It requires more stringent control of existing stationary sources by defining and requiring RACT technology on a case by case basis.
- It imposes controls on area sources, which are in general either mobile or sources too small or numerous to require registration.
- It imposes a strong inspection/maintenance (I/M) program on motor vehicles which reduces emissions below the level achieved with the FMVCP only.

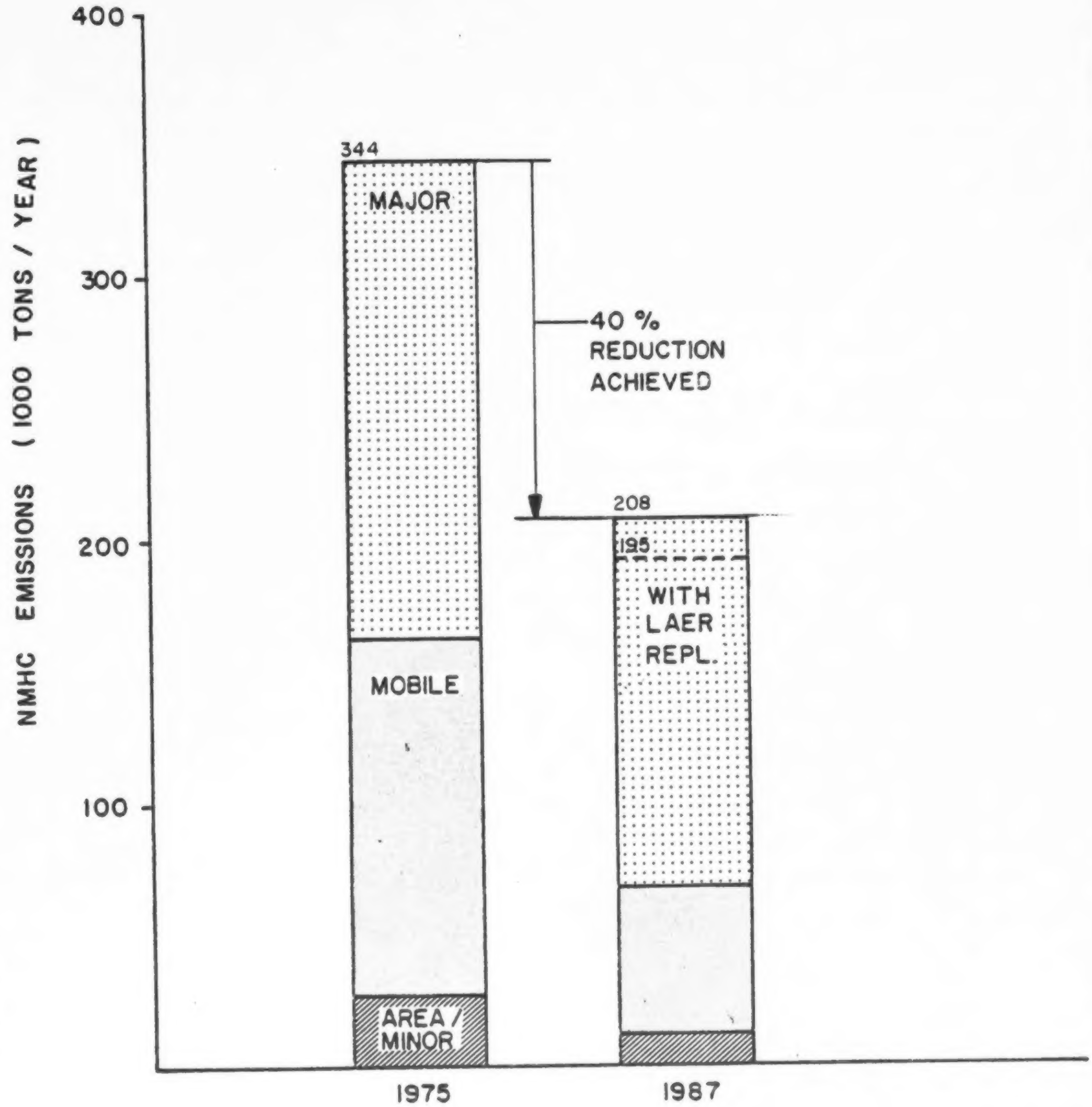
The RACT SIP relies on the initial EPA control technology guidelines and was considered to be implemented on the EPA publication schedule. This stepwise implementation produces stepwise reduction in emissions as compliance is achieved in one industrial sector after another. This process is best illustrated in the graphs of Chapter V which show actually four compliance steps: one in 1978 as compliance with the pre-1979 SIP is wholly achieved followed by the three-step compliance with the RACT SIP revisions in 1982, 1984, and 1986. To test the impact of delays in issuance of the control technology guidelines, a sensitivity analysis was performed. The results of this analysis are presented later in this chapter.

Figure VI-2 is a bar graph comparing emission levels in the base year (1975) with those realized by 1987 under the RACT SIP. From an initial emission level of about 344,000 tpy, a final level of about 208,000 tpy was reached. This reflects a 40% reduction. Major point source emissions decreased about 42,000 tpy or 23% from the base year 1975. Mobile source emissions decreased by 59% from the base year emissions. Emissions from this category were 12,363 tpy lower than the base case scenario because a strong I/M program was assumed to be in effect. Area and minor sources were reduced by 56% from the base year emissions. Emissions from this category were 25,777 tpy lower than the emissions from the base case.

The final emissions level is greater than the two estimates of the level needed to attain the 0.12 ppm ozone standard; 126,014 tpy using EKMA and 143,516 tpy using modified rollback. The graph shows clearly the three sources of reduction.

FIGURE VI-2

II: RACT SIP
WITH MAJOR SOURCE CONSTRUCTION



III: RACT SIP With Emission Offsets

This policy option differs from the RACT SIP option in one detail only: major point sources, those with the potential to emit more than 100 tpy, must obtain offsetting emissions from existing sources before they can be permitted to build or expand existing sources in actual emission increments of 50 tpy. Under this scenario, emissions were reduced by 48% from the base year emissions for the 1:1 offset ratio and 54% under the 3:1 offset ratio (see Figure VI-3). All of the growth projected to occur between 1975 and 1987 could take place with a 1:1 offset ratio; growth would be curtailed in 1988 unless better controls were developed. For the 3:1 offset ratio, 59% of the projected growth could take place; growth would be curtailed in 1983 unless better controls were developed.

In 1987, major sources would be 39% lower than the base year emissions for the 1:1 offset ratio and 49% lower for the 3:1 offset ratio. These levels are significantly lower than the base case pre-1979 SIP scenario and somewhat below the RACT SIP policy option. Mobile and area/minor source emissions were the same as the RACT SIP policy option for the 1:1 offset ratio. Because area sources were used as offsets under the 3:1 policy option, the area/minor source emission category was 8,923 tpy or about 3,000 tpy less than the two previous scenarios analyzed.

Figure VI-3 is a bar graph comparing emission levels in the base year with those realized by 1987 under this policy option. The final emission levels assuming both a 1:1 and a 3:1 offset ratio is greater than the level needed to attain the 0.12 ppm ozone standard; 126,014 tpy using EKMA and 143,516 tpy using modified rollback. The graph depicts clearly the three sources of reduction for each offset ratio.

IV: RACT SIP With No Major Source Construction After 1979

Under this policy, total emissions could be reduced 49 to 52%. This option would provide only about 3,000 tpy fewer emissions than the RACT SIP with offsets policy options described above. However, in this case, only one-fourth of the projected growth could occur between 1975-1987.[1]

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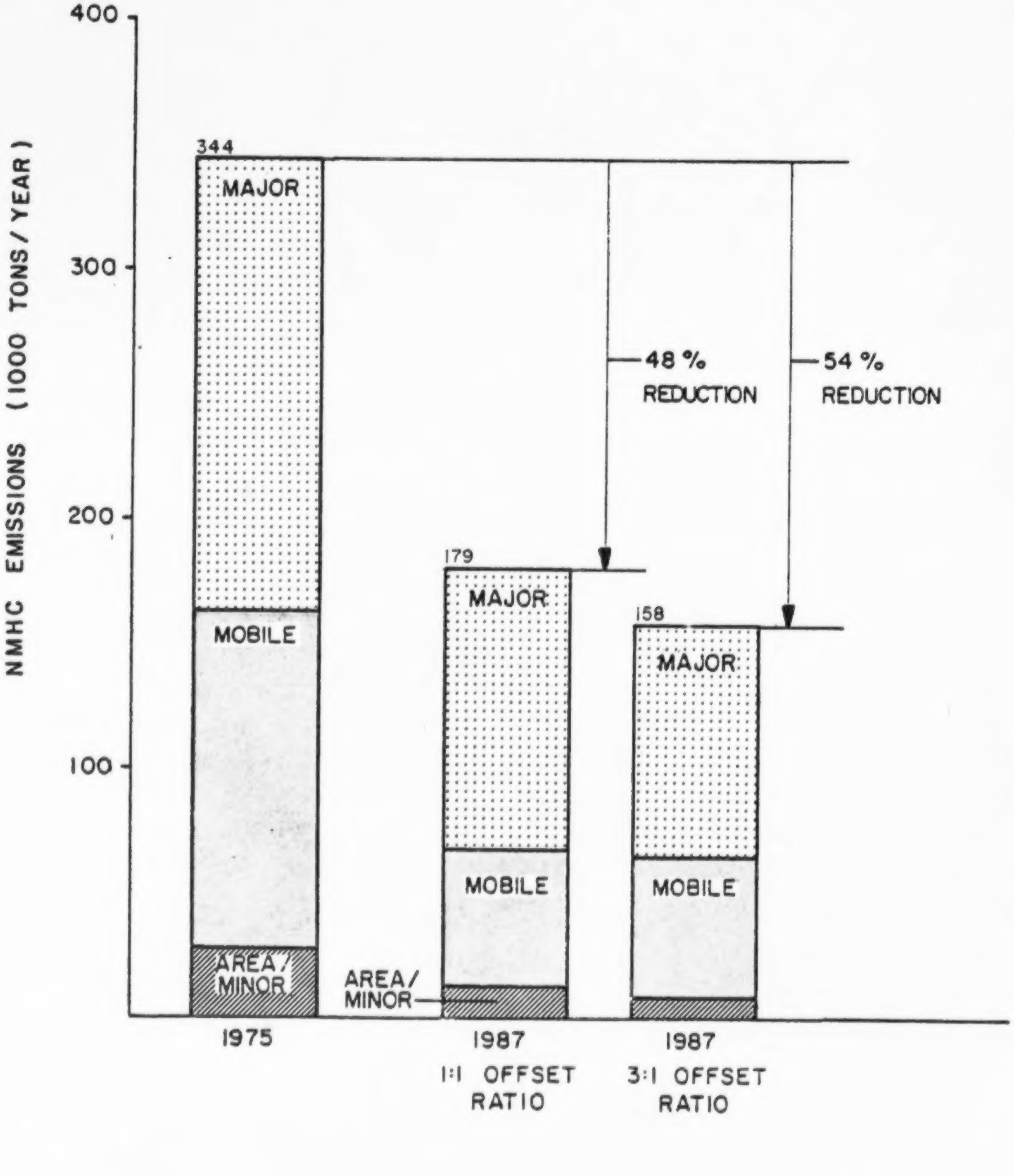
[1] This represents only the growth between 1975 and 1979. After 1979, no growth was assumed.

FIGURE VI-3

III: RACT SIP
WITH MAJOR SOURCE CONSTRUCTION
WITH OFFSETS



Emissions from mobile and area/minor sources were the same as the emissions under the RACT SIP and RACT SIP with 1:1 offsets policy options.

V: LAER Replacement With No Major Source Construction After 1979

This was the most restrictive of the options considered. It produced emission reductions beyond those achieved by the RACT SIP option in three ways:

- It required total replacement of existing point sources, or retrofit with LAER control technology, instead of replacement at the guideline retirement rate.[1]
- It required more stringent controls (RACT-2) on area sources.
- It required a 20% reduction in projectd vehicle miles traveled through transportation control planning.

The emission level achieved in 1987 under this policy option was about 131,000 tpy. This was a 62% reduction from the base year emission level of about 344,000 tpy. It was a 37% reduction from the RACT SIP option and was below the modified rollback estimate of the level needed to attain the 0.12 ppm standard. However, the emission level achieved was above the EKMA estimate for attaining standards.

Potential for Attaining Standard

Figure VI-4 shows a comparison of the policy option emissions with the EKMA and modified rollback emission levels required to attain the new 0.12 ppm ozone standard. The two no-growth policy options are not shown in the figure but all policy options are compared in Tables VI-1 and VI-2 where absolute emissions are tabulated for each scenario along with the percentage reductions.

For new major source construction, the RACT SIP with a 3:1 offset policy was demonstrated to come the closest to attaining the ozone standard by 1987. A 218,000 tpy reduction from 344,000 to 126,000 tpy was required by EKMA, whereas this policy would reduce emissions by 186,000 tpy from 344,000 tpy to 158,000 tpy. A 200,000 tpy reduction from 344,000 to 144,000 tpy was required by modified rollback. On a percentage basis, the EKMA goal was a 64% reduction while the modified rollback goal was 59%. This policy provided 54 percent.

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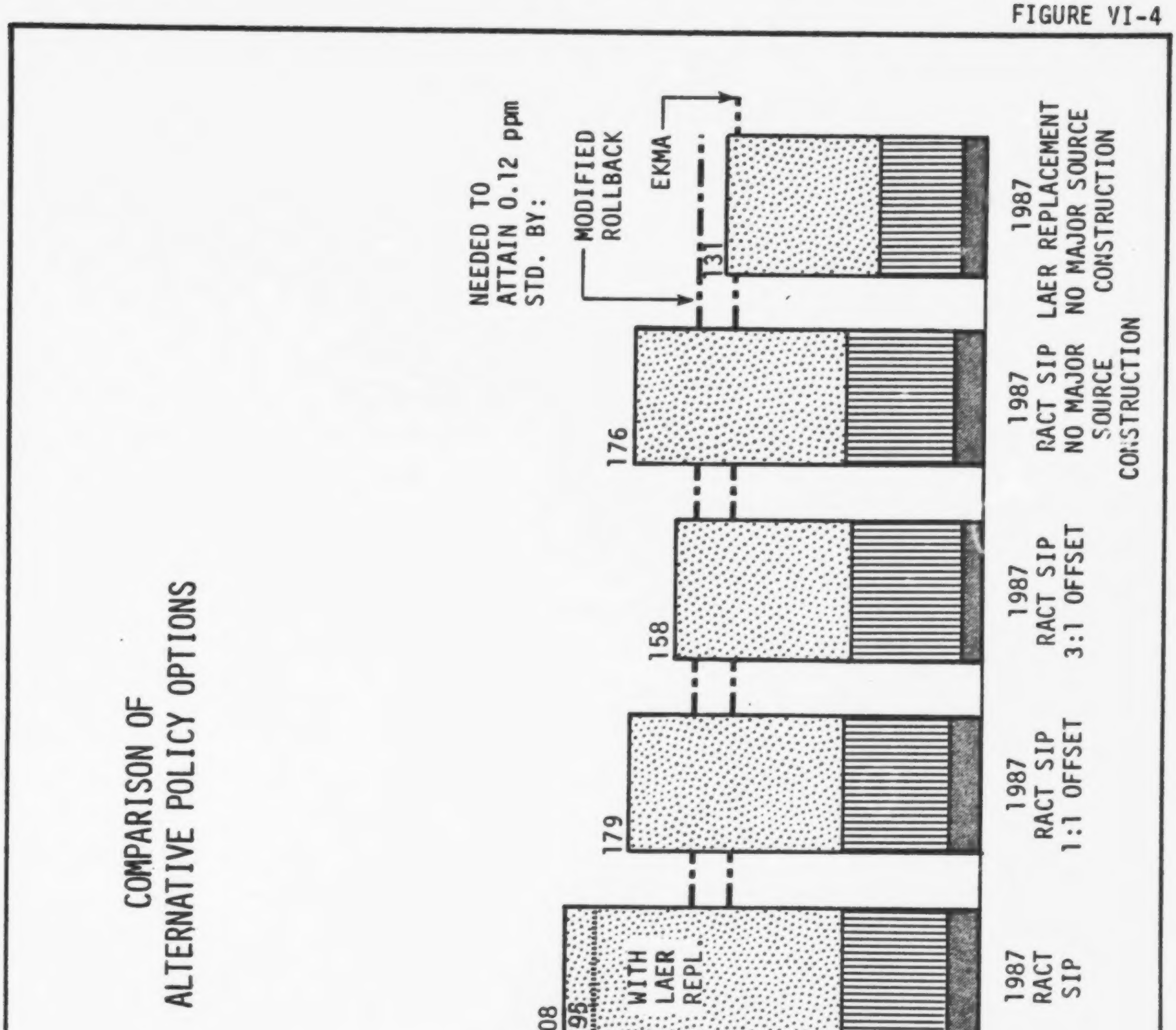
[1] Assuming that the LAER replacement would all take place between 1980 and 1990.

FIGURE VI-4



COMPARISON OF ALTERNATIVE POLICY OPTIONS

TABLE VI-1

COMPARISON OF 1987 NMHC EMISSIONS FOR VARIOUS POLICY OPTIONS
(TONS/YEAR)

SCENARIOS	TOTAL EMISSIONS	MAJOR SOURCES				MOBILE SOURCES	AREA/MINOR SOURCES	POTENTIAL ADDITIONAL REDUCTIONS	
		SUBTOTAL	EXISTING AT SIP	REPLACEMENT OR RETROFIT AT LAER	NEW AT LAER			20% RACT/ LAER IMPROVEMENT	20% VMT REDUCTIONS
1975 Emissions Inventory Used in This Study	343,963	181,710	181,710	N/A	N/A	134,381	27,872	N/A	N/A
1975 TACB Inventory	343,078	209,103	209,103	N/A	N/A	116,782	17,193	N/A	N/A
1987 Emissions									
Base Case:pre-1979 SIP with Major Source Construction	321,578	215,670	173,112	N/A	42,558	67,852	38,056	N/A	N/A
with Replacement at LAER	271,594	165,686	94,597	28,831	42,558	67,582	38,056	N/A	N/A
RACT SIP with Major Source Construction	207,557	139,793	97,235	N/A	42,558	55,489	12,275	25,666	7,953
with Replacement at LAER	194,588	126,834	55,435	28,831	42,558	55,489	12,275	23,082	7,953
RACT SIP with Offsets for Major Source Construction									
1:1	179,329	111,565	966	68,041	42,558	55,489	12,275	20,020	7,953
3:1	157,955	93,543	N/A	68,527	25,016	55,489	8,923	16,415	7,953
RACT SIP with No Major Source Construction after 1979	176,463	108,699	97,235	N/A	11,464	55,489	12,275	19,447	7,953
with Replacement at LAER	163,494	95,730	55,435	28,831	11,464	55,489	12,275	16,853	7,953
LAER Replacement with No Major Source Construction[a]	131,201	79,991	0	68,527	11,464	41,357	9,853	19,410	7,953[b]

[a] For this case, it was assumed that all existing sources were replaced by 1990.

[b] In addition to the 20% already assumed for this scenario.

TABLE VI-2

COMPARISON OF PERCENTAGE REDUCTIONS ACHIEVED IN NMHC EMISSIONS BY 1987 UNDER THE VARIOUS POLICY OPTIONS

SCENARIOS	REDUCTION ACHIEVED BY POLICY %	ADDITIONAL REDUCTION REQUIRED TO ATTAIN 0.12 ppm STANDARD %		WITH ADDITIONAL REDUCTION[a] %	ADDITIONAL REDUCTION REQUIRED TO ATTAIN 0.12 ppm STANDARD %	
		EKMA	MODIFIED ROLLBACK		EKMA	MODIFIED ROLLBACK
Base Case: Pre-1979 SIP with Major Source Construction	7	57	52	N/A	57	52
- with Replacement at LAER	21	43	38	N/A	43	38
RACT SIP with Major Source Construction	40	24	19	50	14	9
- with Replacement at LAER	43	21	16	52	12	7
RACT SIP with Offsets for Major Source Construction						
1:1	48	16	11	56	8	3
3:1	54	10	5	64	0	0
RACT SIP with No Major Source Construction after 1979	49	15	10	57	7	2
- with Replacement at LAER	52	11	7	59	5	0
LAER Replacement by 1990 with No Major Source Construction after 1979[b]	62	2		70	0	0

[a] Includes a 20% RACT/LAER improvement and a 20% VMT reduction.

[b] For this case, it was assumed that all existing sources were replaced by 1990.

The no growth scenarios provided the same order of magnitude reductions but such policies would probably not be acceptable to many decision makers.

While the analyses showed that considerable reductions in emissions could be demonstrated and still allow growth to continue, none of the policy options provided clear evidence of possible standard attainment. Because some individuals may consider the goals within "striking" distance of the projected emission reductions, further analyses were pursued to determine the relative influence of some of the key assumptions on the findings and conclusions of these initial analyses.

SENSITIVITY ANALYSES

To conduct these analyses, the policy option above which had provided the greatest reduction potential - RACT SIP with offsets for new major source construction was utilized. In these analyses, the following seven factors were evaluated.

Emission Inventory Data

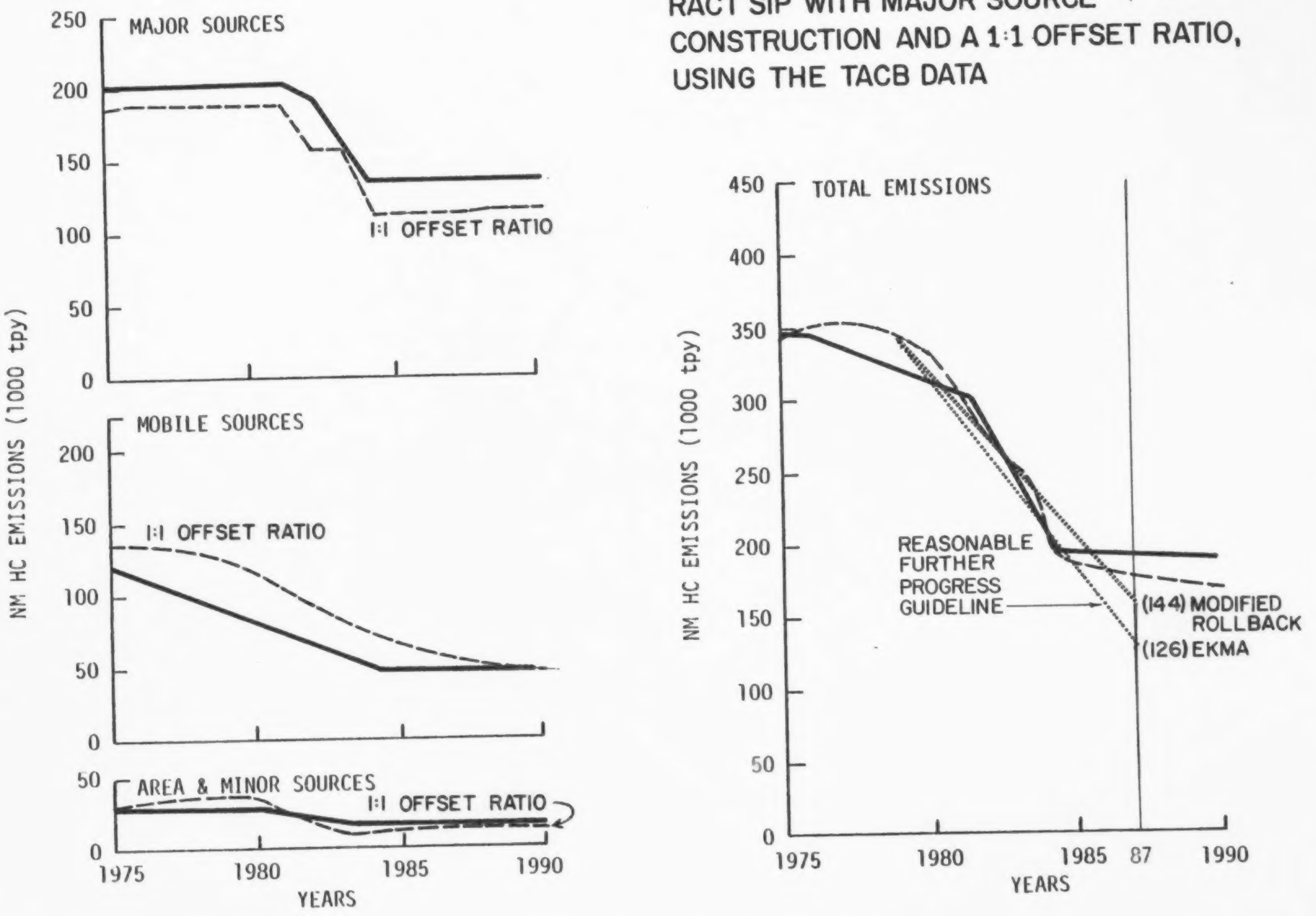
An analysis was made of the comparison between the TACB data published in November 1977 and the ES inventory under the 1:1 offset scenario. (Refer to a discussion of these emissions in Chapter III). Total 1975 emissions for the AQCR were 343,078 tpy. No notable differences were observed between using the ES inventory or the TACB data for the policy options being considered in in this analysis (see Figure VI-5).

Growth Rate Assumptions

Another sensitivity analysis was performed using growth rates other than those obtained from the local planning agencies and other EPA contractors. For this analysis, it was assumed that growth was either 10% lower or 10% higher than that used in the base scenario.

The RACT SIP with offsets again was used to test the sensitivity of growth on air quality. Under the -10% growth scenario, more growth could be accomodated under the 1:1 and 3:1 offset ratio in the study period. Under the 1:1 offset scenario all growth could be accommodated through 1990 and any potential curtailment without additional controls beyond those assumed in this study may occur after 1990. Under the 3:1 offset case, 70% more growth could occur than with a 1:1 offset ratio. For the +10% high growth scenario, growth will be

FIGURE VI-5



RACT SIP WITH MAJOR SOURCE CONSTRUCTION AND A 1:1 OFFSET RATIO, USING THE TACB DATA curtained about 1986. The 1986-87 emissions from major sources would be reduced very slightly due to the lack of offsets in that year or two.

This finding emphasizes the relative leverage toward attaining standards of establishing better controls on existing sources as opposed to developing new control technologies for new sources. Under the offset policy, all new sources must find tradeoffs.

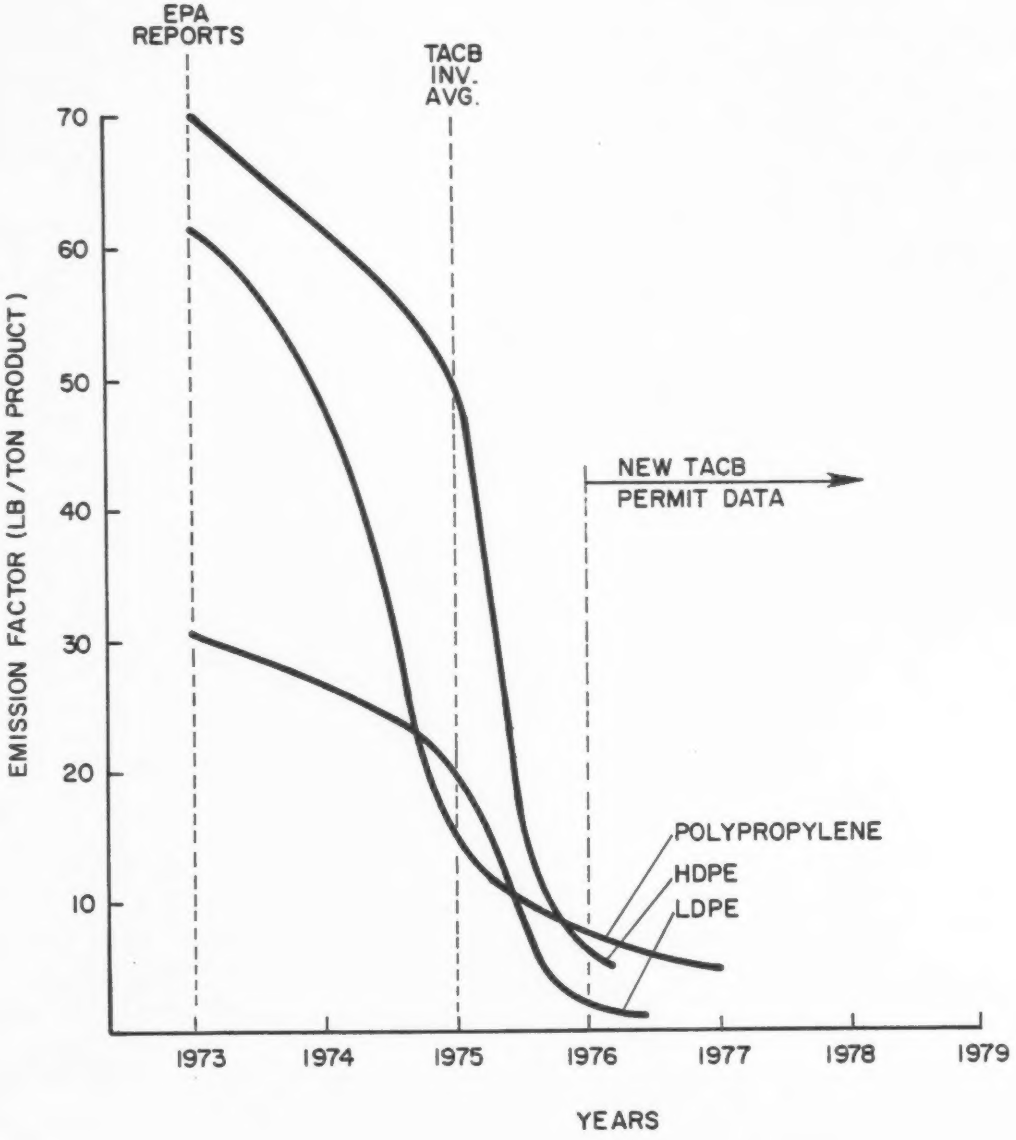
Control Technology Definitions

In developing the control technology definitions and efficiencies for various industrial categories many situations arose where no data existed for defining RACT and LAER. It has already been pointed out that LAER emission factors were unavailable for 41% of projected new emissions; RACT emission factors were unavailable for 22% of existing sources. Default control values as discussed in Appendix B were assigned to these categories. The same problem occurred in defining the potential reductions for fugitive and uncontrolled emissions in the TACB inventory. Rather than question the technology applied to any given industrial process, the assumption could be made that the RACT and LAER definitions used in the earlier analyses were not sufficiently stringent since technology should logically improve further over the next 10 years. An example of how the control technology has improved in recent years is shown for three industrial processes in Figure VI-6. For these three source categories, the emission factor was reduced by 90% which indicates the difference between a 1973 RACT definition and a 1976 LAER definition.

For this analysis, the 1975 RACT emissions from existing major sources would be reduced an arbitrary 20 percent from 97,235 to 77,788 tpy. Likewise, 1990 LAER emissions from new sources would be reduced from 57,060 to 45,648 tpy. The results are shown in Tables VI-1 and VI-2.

For the five area source categories, more stringent controls were assumed. For example, the RACT definition for surface coating was assumed to be 85% control. Since tighter controls were conceivable for this kind of process, emissions were then assumed to be reduced by 90%. If the so-called RACT-2 controls were applied to all of the area source categories, emissions would be reduced by 3,352 tpy below those anticipated with a 1:1 offset policy.

20% RACT/LAER IMPROVEMENTS OVER STUDY ASSUMPTIONS ARE REALISTIC



For the mobile source emission category under the RACT SIP 1:1 offset policy, it has been assumed that the FMVCP was supplemented with an I/M program. If one assumed that a transportation control plan was able to reduce the VMT by 20 percent, then emissions would be further reduced in 1987 by 7,953 tpy.

On the other hand, should the implementation of controls dictated by the initial control technology guidelines (CTG) be delayed (see Table C-1 for schedule), the RFP requirement may not be realized. To test the sensitivity of such delays on meeting RFP in 1982, it was assumed that all CTG sources with pre-1983 compliance dates were not in compliance until 1983. Such a delay would increase emissions by about 25,000 tpy in 1982 to 297,000 tpy for the RACT SIP with offsets for major source construction. Neither offset ratio considered could provide sufficient emission reduction to meet the RFP requirement. As a matter of fact, none of the policy options examined provided sufficient reductions to meet RFP assuming CTG delays.

Motor Vehicle Emission Factors

The EPA's MOBILE 1 emission factor program was used to estimate road vehicle emissions. In Appendix E, the basic input requirements of that program are listed as well as data which illustrate the importance of speed as the key input variable that substantially governed the emission factor. For the policy analysis, road vehicle emissions were calculated using data from the HGRTS office. This resulted in the following emission factors:

	1975		1987	
	Speed (mph)	Factor (gms/VMT)	Speed (mph)	Factor (gms/VMT)
Urban	36	6.25	38	1.13
Rural	49	5.61	49	1.01

Had the national average on speed, hot/cold starts, ambient temperature, etc. been used, the emission factors would be:

	1975		1987	
	Speed (mph)	Factor (gms/VMT)	Speed (mph)	Factor (gms/VMT)
Urban	20	8.75	20	1.85
Rural		(Not available)		

Using the HGRTS speed data resulted in NMHC emissions which were 40% lower in 1975 and 64% lower in 1987 than if the national speed of 20 mph had been

TABLE VI-3

INTRAINDUSTRY OFFSETS AND GROWTH OF EMISSIONS

CHEMICAL MANUFACTURING	RACT[1] OFFSETS	LAER[2] OFFSETS	TOTAL[3]	GROWTH BY 1990
Ethylene	1,551	0	1,551	5,400
Olefins (including some ethylene)	942	0	942	2,080
Low Density Polyethylene	3,405	3,669	7,074	2,250
High Density Polyethylene	394	9,867	10,261	2,620
Ethylene Dichloride	1,746	0	1,746	2,640
Polypropylene	420	1,692	2,112	2,750
Vinyl Chloride	6,310	45	6,355	40
Polyvinyl Chloride	4,924	437	5,361	140
Butadiene	5,273	0	5,273	550
Carbon Black	8,977	509	9,486	0
Cyclohexanone	0	1,990	1,990	1,770
All Other Chemicals	12,668	75	12,743	19,260
Subtotal	46,610	18,284	64,894	39,500
PETROLEUM REFINING	14,356	0	14,356	2,550
PAINTING (ALL INDUSTRIES)	2,307	289	2,596	250
LOADING	10,316	5,008	15,306	480
OTHER POINT SOURCES	1,031	0	1,031	4,920
STORAGE TANKS				
Petroleum	7,661	3,909	11,570	1,940
Chemical	2,194	1,218	3,412	7,420
TOTAL	84,475	28,708	113,183	57,060

[1] Defined as the reduction between 1975 actual emissions and 1975 RACT emissions.

[2] Defined as the additional reduction by going from RACT to LAER emissions.

[3] The sum of RACT and LAER offsets.

used. However, the impact of using the faster HGRTS speed is small (less than 2% for the RACT SIP with 1:1 offsets) in the demonstration of attainment.

Reservoir of Intra-industry Tradeoffs

An analysis was made of the limitation of growth due to available tradeoffs within the same industry category. Table VI-3 summarizes the available offsets and the demand for several major point source categories in the Houston-Galveston AQCR.

For all industry, there were just enough offsets (assuming a 1:1 offset ratio) to accommodate the point source growth in the area. A total of 113,183 tpy offsets were available in 1975. By 1982, 14,047 tpy were eradicated by the SIP. Total offsets used during the period were 25,511 tpy.

In examining the potential offsets available for each industry category, there were several chemical manufacturing industries which expected more growth than could be accommodated by offsets within that same industry. Ethylene (olefins), ethylene dichloride, and polyproplyene expansions will likely have to rely on offsets from refining or from the manufacture of other chemical compounds. In total, though, there were 64,894 tpy of available offsets in the chemical industry and a demand, due to new source growth, of 39,500 tpy.

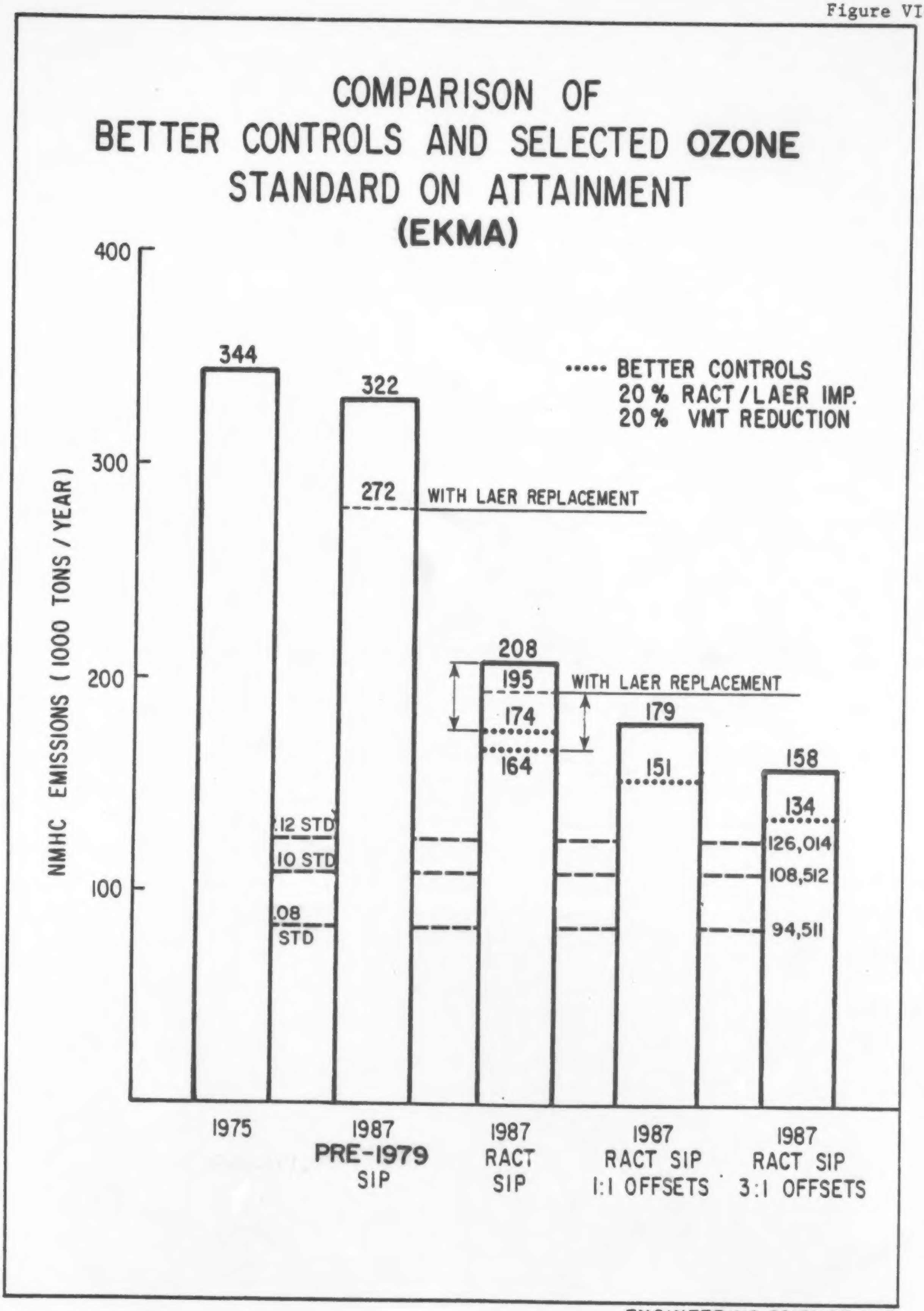
Selected Ozone Standard

The goal to attain the 0.12 ozone standard was a 64% reduction of NMHC down to a level of 126,000 tpy using EKMA. The goal was 59% using modified rollback. If the standard is lower than 0.12 ppm, the impact can be quickly observed in Figures VI-7 and VI-8. If the 0.08 ppm standard had been retained or the 0.10 ppm selected, none of the policy options could demonstrate attainment.

Calculation Method

From Chapter IV, it will be recalled that the required reductions ranged from 56 to 64 percent. This investigation utilized percent reductions of 59 and 64 to calculate the goals of about 144,000 and 126,000 tpy, respectively. If an additional 5 percent reduction had been required, then the goal would have decreased 17,000 tpy, further below the level of emissions anticipated under any of the policy options.

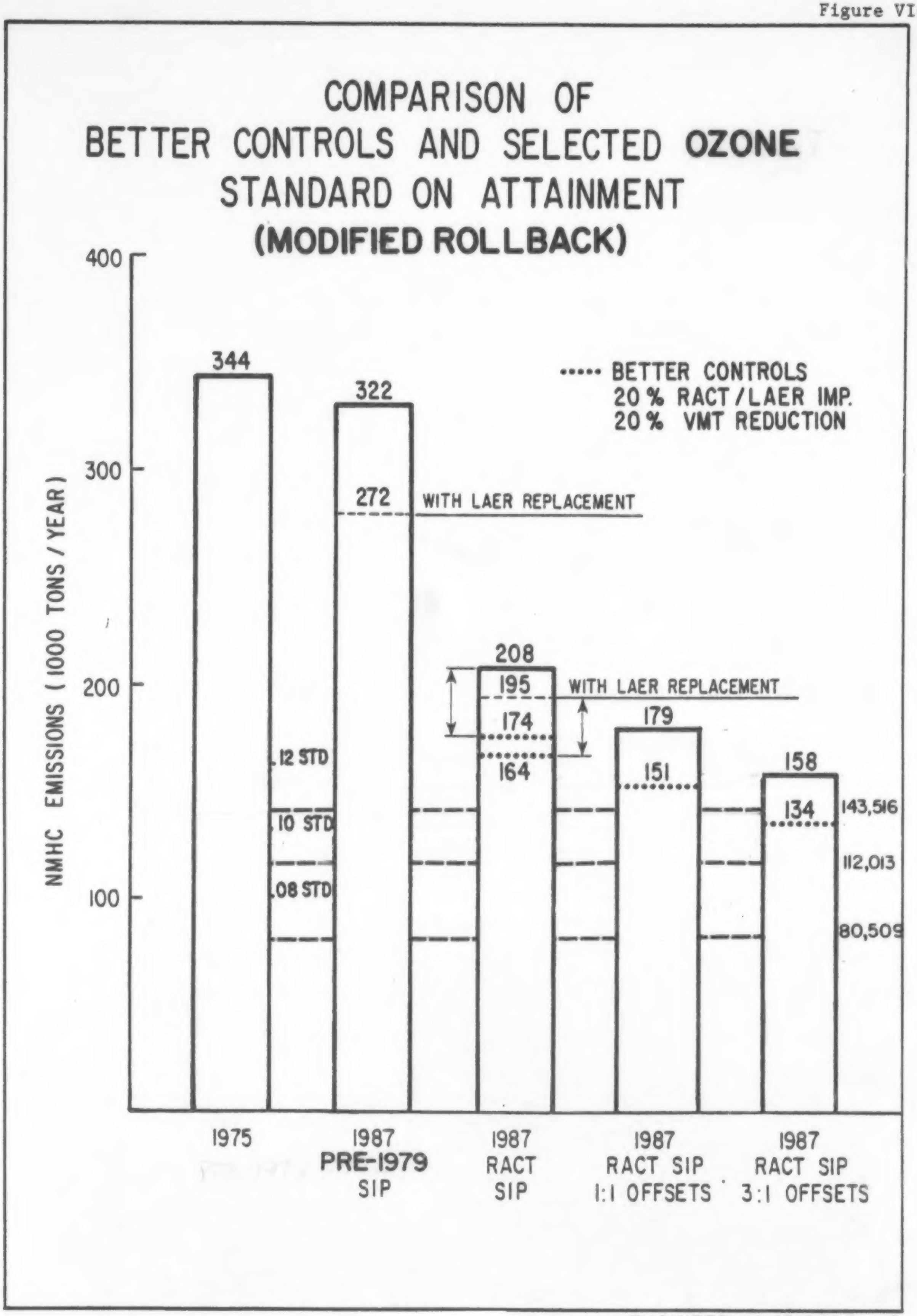
Figure VI-7



COMPARISON OF BETTER CONTROLS AND SELECTED OZONE STANDARD ON ATTAINMENT (EKMA)

ENGINEERING-SCIENCE, INC.

Figure VI-8



COMPARISON OF BETTER CONTROLS AND SELECTED **OZONE** STANDARD ON ATTAINMENT

(MODIFIED ROLLBACK)

APPENDIX A

OZONE DESIGN VALUE FOR HOUSTON-GALVESTON

The formation of ozone (O_3) from a complex mixture of hydrocarbons (HC) and nitrogen oxides (NO_x) in the presence of sunlight is not well understood. It is clear that the old Appendix J method[1] was too simplistic in that it assumed no background O_3 or HC concentration. Both are known to be important, although natural HC emissions (such as terpenes) may be truly insignificant. Further, not only is the transport of O_3 and HC into an urban area important to the maximum attained in a given day, but also the continued reaction within the plume drifting downwind must be considered. Oftentimes, the metropolitan monitors do not record the highest O_3 values. Thus, the problem of determining maximum values attained may require long periods (years) of observations at many locations subject to the area plume. The statistical distribution of extreme values is important as a measure of population exposure. A carefully selected extreme value, the O_3 design value, represents the present exposure and determines the amount of reduction necessary to attain the standard.

The O_3 design value for Houston was selected based on "Guideline for Interpretation of Ozone Air Quality Standard (DRAFT)" (OAQPS No. 1.2-108). Monitoring site 452330024F01[2] was used because it measured the highest O_3 concentrations during the three-year period 1975-1977. A summary of the O_3 hourly values exceeding 0.20 ppm in Houston is given in Table A-1. During the three-year period, 17,529 observations were collected. The highest O_3 concentrations, 0.32 and 0.30 ppm, were measured on June 13, 1975. These values are highly suspicious, with an hourly concentration of 0.211 ppm measured at 10:00 a.m. followed by 0.321 ppm at 11:00 a.m., 0.300 ppm at 12:00 a.m., nothing at 1:00 p.m., and 0.14 ppm at 2:00 p.m. In fact, the third highest O_3 concentration measured in 1975 is 0.21 ppm out of 5,943 observations (see Table A-1).

Rejecting the two highly suspicious values from consideration, one would choose 0.26 ppm as the design value based on the old form of the standard.

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[1] 40 CFR Part 51, Requirements for preparation, adoption, and submittal of implementation plans.

[2] Aldine Monitoring Station.

TABLE A-1

SUMMARY OF OZONE HOURLY VALUES EXCEEDING 0.20 PPM IN HOUSTON AT ALDINE MONITORING STATION FOR THE YEARS 1975, 1976, AND 1977

O_3 LEVELS (ppm)	YEARS 1975	 1976	 1977
.20	0	1	3
.21	5	4	2
.22	0	3	2
.23	0	1	2
.24	0	2	0
.25	0	1	1
.26	0	0	2
.27	0	1	1
.28	0		
.29	0		
.30	1		
.31	0		
.32	1		

The maximum and second maximum hourly concentrations for the three years are summarized below in ppm:

	1975	1976	1977
Max. Hour	0.21*	0.27	0.27
2nd Max. Hour	0.21	0.25	0.26

* Rejecting the two highest readings in 1975.

The highest second maximum hourly concentrations would be selected, based on the guidance provided in the CPDD workbook.[1]

Using the new statistical form of the standard, the design value would be expected to lie between the second and third highest hourly concentrations over the three-year period. The data point used for the design value is the second highest or 0.27 ppm. (See Table 1, page 23A, in OAQPS Guideline No. 1.2-108, referenced earlier.) Figure A-1 illustrates the procedure used to estimate the 0.27 design value.

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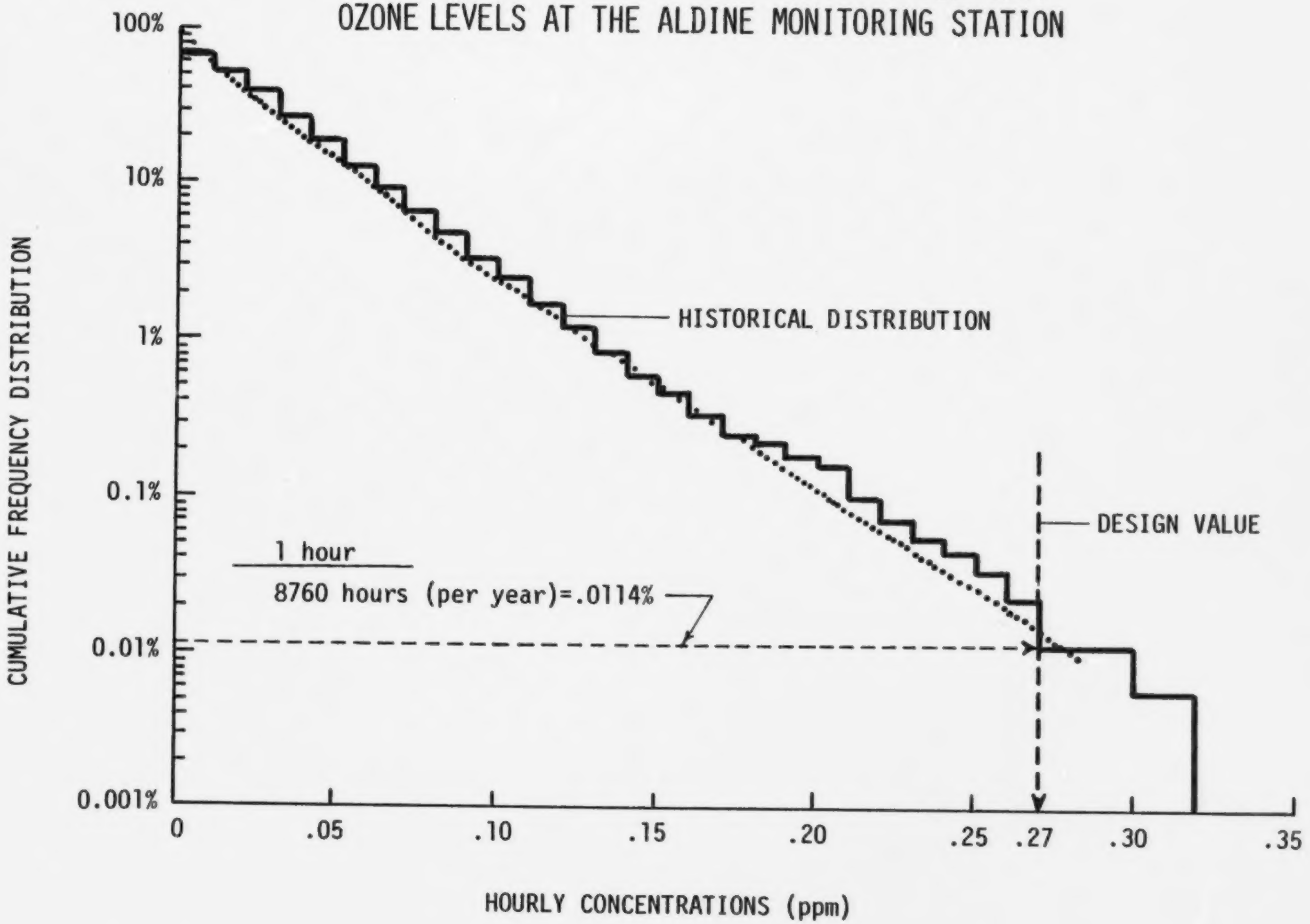
[1] "Workshop on Requirements for Nonattainment Area Plans", Presentations by EPA, Philadelphia, Pa., March 1978.

FIGURE A-1

STATISTICAL ANALYSIS OF 1975,1976, AND 1977
OZONE LEVELS AT THE ALDINE MONITORING STATION



APPENDIX B

METHODOLOGY AND ASSUMPTIONS FOR CALCULATING EMISSION REDUCTIONS

Ozone formation depends upon the ambient levels of hydrocarbons. These ambient levels are determined by the hydrocarbon emissions in the area. Reduction in these emissions is achieved by the more stringent control technology required by the amendments of 1977. RACT and LAER represent control levels which usually must be specified for each process in each plant; however, more general definitions have been established for the purposes of this study which may be applied to all plants with a common process. These definitions are presented in Appendix C. We are concerned here with the method of applying them to the base year point source emission inventory in order to determine the new or resulting emission level. The ensuing discussion describes the methodology which was used for calculating the emissions for the RACT and LAER emission control scenarios. Emissions are of primary importance to this study.

METHODOLOGY AND ASSUMPTIONS

Three basic inputs are required in order to calculate emissions using the RACT and LAER definitions of Appendix C:

- production data by process;
- RACT/LAER emission factors; and
- actual 1975 emissions (e.g., regulated, unregulated, and fugitive in the case of HC).

Production data were derived from several sources. Mainly, the information was obtained from the 1975 point source inventory of the Texas Air Control Board (TACB). For those sources which had confidential information, the production data had to be estimated from published sources or obtained directly from the company. The emission control definitions of RACT and LAER have been described in Appendix C of this report. These factors were organized by source classification codes (SCCs) which correspond to each industrial process within the Texas inventory. The actual emissions of each individual process were also obtained from the 1975 TACB inventory. As discussed in Appendix E, the emissions of HC were divided into three categories: regulated HC emissions, unregulated HC emissions, and fugitive HC emissions. The emissions from the TACB represented the total actual emissions for that time period. It was not possible to calculate SIP allowable emissions for the HC sources in this study.

Figure B-1 illustrates the calculation methodology used to determine HC reductions for this analysis. The three data files described above were the basic inputs. If a factor was available, calculations to estimate emissions were made by taking the production rate (activity level) for each individual process and multiplying this quantity by the appropriate RACT/LAER emission factor. There were instances where the actual emissions were lower than those which were calculated for RACT or LAER emissions. In all cases, a comparison of the calculated RACT/LAER emissions with the actual emissions for that process was made. The lower of these two emission values was then summed for all processes in the AQCR.

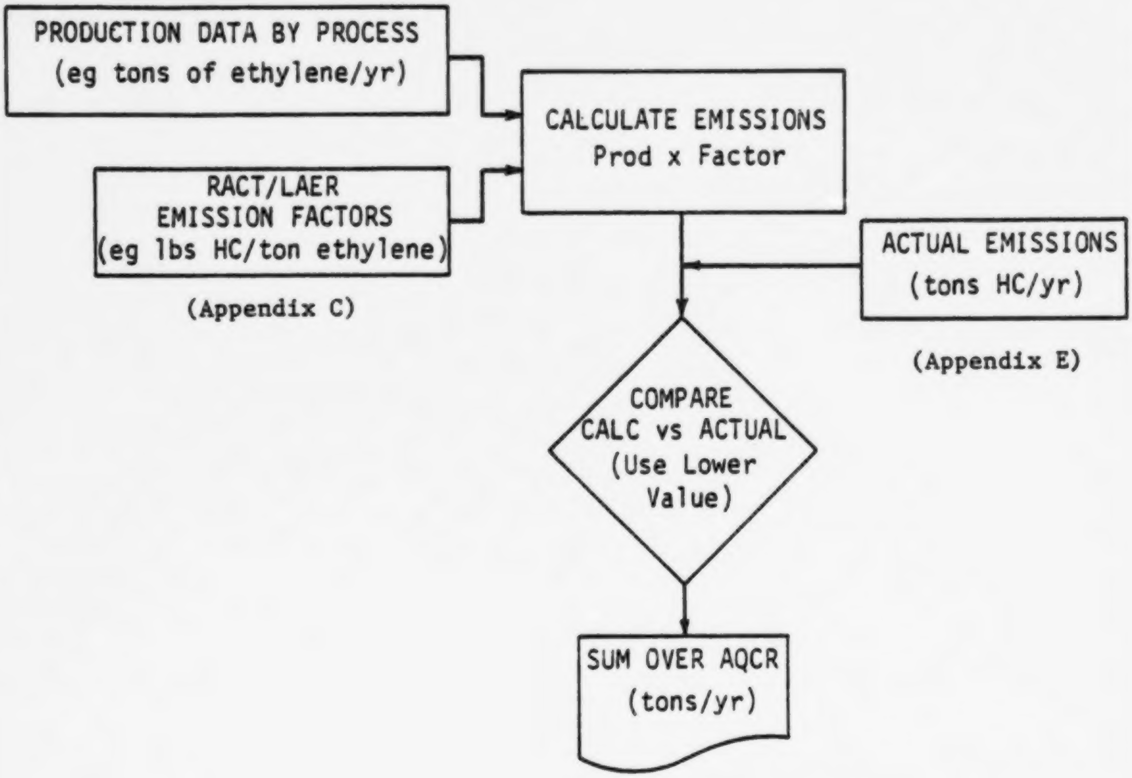
In those cases where a RACT or LAER emission factor was not available, other assumptions were made. If there were no LAER emission factors, but a factor did exist for RACT, the RACT factor was used for the LAER calculation. This was the case for 36.6% of the total point source emissions in the Houston-Galveston HC inventory. There were several occasions when the control technology using LAER was available but nothing was found for RACT (reflecting about 1.5% of the total point source emissions). In these instances, no substitution of the control technology definitions was made. Obviously, LAER control technology could not be used to calculate RACT.

When neither the RACT nor the LAER factor was available, a percentage reduction was assumed for the unregulated and fugitive portions of the HC emission inventory as reported in 1975. For this base scenario calculation, it was assumed that the unregulated emissions could be reduced by 75% and that fugitive emissions could be reduced by 50%. Thus, all unregulated emissions for a single process were multiplied by 0.25 and the fugitive emissions for that process were multiplied by 0.5. These two values were then added to actual emissions and summed along with other processes in the inventory over the AQCR.

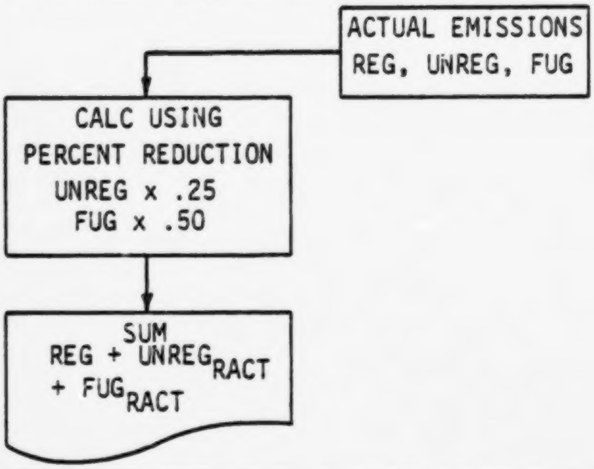
A computer program was devised to facilitate the handling of the large volume of data associated with calculating emissions under these different circumstances. The calculations were made for each process within a plant, for each plant within the AQCR, and then summarized over the entire AQCR.

FIGURE B-1

METHODOLOGY FOR CALCULATING EMISSIONS USING RACT OR LAER ON MAJOR POINT SOURCES


PRODUCTION DATA BY PROCESS
(eg tons of ethylene/yr)
RACT/LAER
EMISSION FACTORS
(eg lbs HC/ton ethylene)
(Appendix C)
CALCULATE EMISSIONS
Prod x Factor
ACTUAL EMISSIONS
(tons HC/yr)
(Appendix E)
COMPARE
CALC vs ACTUAL
(Use Lower
Value)
SUM OVER AQCR
(tons/yr)

If there are no Control Technology Definitions for a process:[a]


ACTUAL EMISSIONS
REG, UNREG, FUG
CALC USING
PERCENT REDUCTION
UNREG x .25
FUG x .50
SUM
REG + UNREG$_{RACT}$
+ FUG$_{RACT}$

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[a] The methodology and assumed percent reductions were the same for RACT and LAER emissions.

SAMPLE CALCULATION

One ethylene unit in the Houston-Galveston inventory produced 200,000 tons of ethylene per year (400 million lbs/year). The SCC code for ethylene is 3-01-161-01. The RACT emission factor for ethylene, using the pyrolosis process, was 1.44 lbs/ton of product produced. With this production rate and emission factor, the RACT emissions were calculated to be 288,000 lbs/year or 144 tpy. The actual emissions for this particular ethylene unit were 427 tpy. Thus, applying RACT to this particular unit would reduce emissions by 283 tpy (427 minus 144).

There was no LAER factor available for ethylene. When calculating the emissions for LAER for all ethylene processes, the RACT emission factor was used. For the same process, exactly the same emission reduction would have been reported for LAER as for RACT.

APPENDIX C

EMISSION CONTROL DEFINITIONS

In investigating the effect of various policy options in the attainment of the ozone standard in the Houston-Galveston AQCR, the control technologies that could be applied to new and existing stationary sources had to be identified. It was the purpose of this study to test the AQCR-wide effects of various policy options. Hence, it was not appropriate to conduct a detailed examination of the emission characteristics of each plant as probably would be necessary for revision of the State Implementation Plan (SIP). A generalized approach that addressed identical emission processes/sources in the AQCR uniformly as a group was used. This approach incorporated the best judgment of the emission factors and corresponding control technologies to estimate future emission levels.

BACKGROUND

Emission Factor Concept

An emission factor relates the quantity of pollutants emitted to some activity indicator such as production, capacity, or quantity of fuel burned. The factor normally corresponds to a specific type of activity but is, in most cases, based on statistical or estimated averages for a specific process. As such, the factor does not permit one to estimate emissions accurately from an individual installation but is acceptable when applied to a large number of similar processes, as was done for this analysis. The emission factor concept is ideally suited to this study because AQCR inventories were developed as part of an area-wide policy option study.

While emission factors have reached a sophisticated level of for particulate sources, such is not the case for many hydrocarbon sources. This is especially true for the petrochemical industry, which is very predominant in the Houston-Galveston AQCR. Particulate sources tend to have "standardized" equipment that does not vary much from plant to plant. Control technology is also quite standard. Baghouses, for example, are used in many different industries to control particulate emissions. For manufacture of a given petrochemical, however, several entirely different processes may be used.

Petrochemical plants are often custom-designed for a particular process or location. As a result, variability exists from plant to plant even though identical process types are employed to manufacture the same chemical. Control methods are usually associated with some type of process modification that can also vary from plant to plant for the same process. Consequently, for petrochemical manufacturing, emissions may not be proportional to production making the development of an emission factor very difficult. As will be discussed later, some problems were encountered in applying the hydrocarbon emission factor concept to the petrochemical industry.

Sources of Information

Engineering-Science did not conduct original research in developing control technology definitions. Such a task would require a substantial manpower effort, an effort of much greater magnitude than that anticipated for this study. In this analysis, control technology definitions already developed from other research efforts were used. The data deficiencies found to exist after the evaluation of available information were corrected with the aid of EPA's Emission Standards and Engineering Division (ESED). A parallel investigation was conducted by another EPA contractor for the Chicago AQCR. The EPA Project Officer reviewed both sets of technologies for the purpose of standardization of definitions for identical processes.

The types of control technology references used consisted of documents prepared by EPA's Office of Air Quality Planning and Standards, Emissions Standards and Engineering Division (ESED) and several prepared by contractors for various EPA offices and divisions. The ESED publications were Control Technique Guidelines (CTG) or standard support documents for miscellaneous refinery sources, various sources of volatile organic compounds, solvent metal cleaning operations, surface coating, tank truck gasoline loading terminals, and vinyl chloride manufacturing. The EPA document, Compilation of Air Emission Factors (AP-42), provided control technology data for a wide variety of air pollution sources. Reports from the EPA contractors--Radian Corporation, The Research Corporation of New England, Pacific Environmental Services, PEDCO Environmental, and the Houdry Division of Air Products and Chemicals--provided information for a wide range of processes, including the petrochemical, petroleum, and iron and steel industries.

The Houdry surveys were the main data references used for processes associated with the petrochemical industry. The survey reports provided both controlled emission factors (weighted average based on production rate) and typical control efficiencies. The typical control efficiency as noted in the Houdry Reports was not necessarily consistent with the controlled emission factor since the factor was a weighted average of all plants surveyed by Houdry. ES chose to adopt the controlled emission factor efficiency (e.g., 99% for flares), primarily because a controlled emission factor was required for study purposes. This methodology provided more realistic estimates of the RACT/LAER emission levels for the purpose of this study in view of the type of process information obtained from the Texas Air Control Board (TACB).

Engineering-Science also visited the ESED offices to discuss the availability of control technology information for specific processes. Approximately 20 ESED staff members were identified as having expertise in control technology. ES requested assistance from several of the staff members in areas for which control technology information was lacking or inconsistent.

The Project Officer and ESED personnel reviewed the definitions prepared in the previously described manner. The definitions were standardized with those obtained in the Chicago study and missing definitions were provided by ESED. After final review, the Project Officer approved the definitions for use in estimating emissions for the various policy options.

RACT/LAER Definitions[1]

The control technology that is feasible for a new plant may not be acceptable for an existing plant from an economic or technological standpoint. The new plant technology may involve a process modification or other hardware change that would be difficult or impossible to install at an existing plant. An existing plant may not have the space or structural capability to apply new plant technology. Any number of similar circumstances may prohibit the application of the same technology to both new and existing plants.

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[1] An internal EPA Task Force has been formed to determine how best to handle new construction in areas exceeding national standards and how to achieve those standards expeditiously, in a fair and effective manner. A series of studies in addition to this one for the Houston-Galveston area are being conducted to assess the air quality and economic impacts of the current statutory framework and alternative policies. The work of this Task Force should be completed by October 1978. In the interim, ES used the list of emission control assumptions that have been developed for major emission sources. It is important to stress that the control technology assumptions are not regulatory and do not relate to any regulatory program development either national or specific to these regions.

Reasonably Available Control Technology (RACT)

RACT is that level of control of existing stationary source emissions that can reasonably be retrofitted to existing processes, taking technological feasibility and cost into account. By law, it is the level of control that the states will adopt in revised implementation plans in 1979 subject to EPA approval. In some instances, it will provide solely for attainment of standards by December 31, 1982. In others, it will be more stringent at the state's discretion in order to provide an additional margin for growth. In the case of ozone or carbon monoxide, the 1979 RACT SIP revisions may not provide for attainment by 1982. An attainment date extension is permitted until 1987 and the SIP may be submitted in stages with the final submission in 1982.

Clearly, RACT is likely to vary from state to state, from region to region, and even from source to source. This poses a difficult analytical problem in conducting the policy studies. This EPA AQCR study does not take cost into account. We rely upon a range of control assumptions to represent RACT, recognizing that RACT is likely to vary and that certain highly efficient emission control technologies are not readily retrofitted to existing sources where less efficient technologies are currently in use.

Lowest Achievable Emission Rate (LAER)

LAER is defined in the 1977 Amendments to the Clean Air Act as the more stringent of the lowest emission rate achieved in practice or the lowest SIP emission limitation achievable for a class or category of sources. It is currently required of all major new or modified sources requesting permission to construct in nonattainment areas. It will continue to be required by all states in nonattainment areas until national ambient air quality standards are achieved and maintained.

Use of Factors

EPA defines RACT as the lowest feasible emission limit that a source is capable of meeting by the application of economical control technology. The determination of RACT may vary from source to source due to source configuration, retrofit feasibility, operation procedures, raw materials, and other characteristics. For the analysis, such variables could not be considered. As a result, RACT determinations were based on control technologies reported for existing sources and on engineering judgment when control technology found in one of the references was not specifically identified as RACT. The RACT definitions provided herein may not apply to any individual plant because source to source technical and economic characteristics were not considered. EPA is currently in the process of developing generalized RACT guidelines which should be utilized to assist in the definition of RACT for specific plants or sources.

EPA defines LAER as the lowest achievable emission rate, not taking into account economic constraints. In this study, however, no economic factors were considered in defining LAER. When a control technology was not identified in a reference as LAER or Best Available Control Technology (BACT), the technology that allegedly produced the greatest reduction for new sources was adopted. A complicating factor in defining LAER is that it can change rapidly due to new control or process technology. LAER is not an easy term to define for a given time period; the use of current engineering data is essential. ES did not attempt to define LAER in this study and it should be understood that the approach used relied largely on published material some of which was several years old. EPA is conducting studies to coordinate through a central clearinghouse the advances in LAER control technology from all new plants in the United States for future studies.

The RACT and LAER values found in the references took the form of percent reduction of uncontrolled (or partially controlled) emissions or a "controlled" emission factor. If only a percent reduction was provided, a controlled emission factor was, in most cases, calculated by ES by utilizing the percent reduction and the uncontrolled (or partially controlled) emission rate from EPA's Compilation of Air Pollutant Emission Factors, AP-42.

SUMMARY OF CONTROL TECHNOLOGIES

Engineering-Science prepared tables (located at the end of this section) summarizing control technologies for major industrial processes identified in Appendix E of this report. Total emissions from these plants represented about 90% of the AQCR nonmethane hydrocarbon emissions for calendar year 1975 from point sources. For control technology evaluation, all point sources, based on the source classification code (SCC), with significant emissions were selected from these plants.

Each table contains data for a single major industry category as defined by the SCC. The sources within the major categories are arranged in alphabetical order according to process description. The SCC is provided from the current National Emission Data System (NEDS) listing and from the current Texas Air Control Board (TACB) listing, if different from NEDS.[1] The process emission units corresponding to the specified emission factors are included in the tables.

Three different emission factors are specified in the tables. The first is the uncontrolled emission factor and, if know, the fugitive portion of the factor. The remainder of the table is devoted to RACT and LAER definitions. For each technology, the applicable abatement method, corresponding controlled emission factor, and data references are specified. It should be mentioned that the "range of control" and the "uncontrolled emission factor" for the chemical manufacturing industry are not, in all cases, consistent with the "controlled emission factor". This is because a given process may have several emission points associated with it, not all of which are to be controlled with the specified abatement method.

In addition, the controlled emission factors obtained from the Houdry surveys represent the average (weighted for production rate) of the plants that responded. In the survey reports, there was no attempt to provide the controlled emission factor corresponding to the control efficiency specified by Houdry. Because the controlled emission factor was an average value while the specified efficiency was not, the two values were not consistent and would not result in the same emission level. For estimating emissions, ES chose to use the controlled emission factor reported by Houdry rather than the efficiency. It was not felt that there was sufficient data or justification to attempt to develop an (averaged) uncontrolled factor which could be used with the control efficiency to estimate the controlled emission factor.

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[1] Most of the new TACB codes are currently being incorporated into the EPA NEDS master list.

A summary of the control technoligies used in our analysis is shown in Table C-2.

TIMING FOR ISSUANCE, ADOPTION, AND IMPLEMENTATION OF EMISSION CONTROL TECHNOLOGIES

Presently, there is little published information of RACT and LAER controls for major hydrocarbon emission sources. As a result, EPA is in the process of reviewing these source categories and in the future will be publishing guidelines on controls for volatile organic compounds. Because not all of the control technologies for hydrocarbons are known at this time, the schedule of when these technologies would become available (and as a result be incorporated into the implementation plan) is of major importance to this study. As long as the control technology is not specified as an emission regulation in the SIP, those source categories can be credited as offsets, thus allowing more growth to occur in a specific area.

The EPA will be issuing guidelines over the next two or three years which will cover all hydrocarbon emissions sources. Table C-1 shows the schedule of when the guideline documents will be issued, when they are expected to be incorporated as part of the SIP, and when attainment with the new SIP is expected. The latest document is scheduled to be issued in June 1979. The expected attainment for all of the hydrocarbon sources is December 1985.

In Table C-1 under the Guidance Issued column, the check marks refer to those documents which have already been issued by EPA and which are expected to be included as part of the January 1979 SIP submittal. Eleven documents already issued cover about 15% of all of the hydrocarbon emission sources in the Houston-Galveston AQCR.

TABLE C-1

SCHEDULE FOR ISSUANCE, ADOPTION, AND IMPLEMENTATION OF GUIDELINES FOR SOURCES OF VOLATILE ORGANIC COMPOUNDS

	Guidance Issued[1]	SIP Revision Date	Attainment Date[2]
Gasoline & Crude Oil Storage	✓Dec. 1977	June 1979	Dec. 1981
Gasoline Marketing			
Service stations-Stage 1	✓ Issued	June 1979	Dec. 1981
Bulk terminals	✓Oct. 1977	June 1979	Dec. 1981
Bulk Plants	✓Oct. 1977	June 1979	Dec. 1981
Gasoline Marketing			
Service stations-Stage 2	June 1978	Dec. 1979	Dec. 1983
Ship and barge transfer	Dec. 1978	June 1980	Dec. 1983
Petroleum Refining			
Sources	✓Oct. 1977	June 1979	Dec. 1981
Fugitives	June 1978	July 1980	Dec. 1983
Natural Gas & Crude Oil Production	NYS[3]	Dec. 1981	Dec. 1985
Natural Gas & Natural Gasoline Plants	NYS[3]	Dec. 1981	Dec. 1985
Organic Chemical Manufacture			
Process streams & fugitives	Dec. 1978	June 1980	Dec. 1983
Waste disposal & storage and handling	June 1979	Dec. 1980	Dec. 1985
Other Manufacture Pharmaceuticals Paint Manufacture Vegetable Oil Processing	June 1978	July 1980	Dec. 1983
Surface Coating			
Automobiles, Cans, Metal	✓Oct. 1977	June 1979	Dec. 1981
Coils, Paper, Fabric products	✓Oct. 1977	June 1979	Dec. 1981
Metal Furniture, Large Appliances	✓Dec. 1977	June 1979	Dec. 1981
Magnet Wire Insulation	✓Dec. 1977	June 1979	Dec. 1981
Surface coating of Wood furniture			
Other metal products	June 1978	July 1980	Dec. 1983
Plywood and panneling	June 1978	July 1980	Dec. 1983
Architectural & misc. coatings	Dec. 1978	June 1980	Dec. 1983
Wood furniture	Dec. 1978	June 1980	Dec. 1983
Surface coating, industrial finishes, other auto refinishing	NYS[3]	Dec. 1981	Dec. 1985
Adhesives	NYS[3]	Dec. 1981	Dec. 1985
Degreasing	✓ Oct. 1977	June 1979	Dec. 1981
Drycleaning	Dec. 1978	July 1980	Dec. 1983
Cutback Asphalt Paving	✓Dec. 1977	June 1979	Dec. 1981
Rubber Products	June 1978	July 1980	Dec. 1983
Graphic Arts(printing)	June 1978	July 1980	Dec. 1983

1. Walsh, Robert T., Release of Guidelines for Sources of Volatile Organic Compounds. Nov. 22, 1977.

2. Photochemical Oxidant Working Group. (Ken Lloyd principal author) Unpublished implementation schedule of when compliance can be reasonably expected if Guidelines for Sources of VOC are issued on schedule.

3. NYS = Not Yet Scheduled.

TABLE C-2

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY EXTERNAL COMBUSTION BOILER

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Electric Generation - Bit. Coal >100 MMBtu/hr Pulv. Wet & Pulv. Dry	10100201 & 10100202	lb/ton burned	0.30	none	0%	0.3	Ref. 20	Combustion Controls	99.9%	negligible	Ref. 20
Electric Generation - Residual Oil >100 MMBtu/hr Gen.	10100401	lb/10^3 gal. burned	1.0	none	0%	1.0	Ref. 20	Combustion Controls	99.9%	negligible	Ref. 20
Industrial - Residual Oil (and Commercial/ Institutional)	10200401, 10200402, 10300402, & 10300403	lb/10^3 gal. burned	1.0	none	0%	1.0	Ref. 20	Combustion Controls	99.9%	negligible	Ref. 20

DATA REFERENCE:

20. Control Technology Definitions Utilized in Chicago-Gary Non Attainment Study, Argonne National Laboratory, December, 1977.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY INTERNAL COMBUSTION

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Distillate Oil Turbine - Electric Generation & Industrial	20100101 & 20200101	lb/10^3 gal burned	5.57	none	0%	5.57	Ref. 20		99.9%	negligible	Ref. 20

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Acetaldehyde (Ethylene) No Fugitive Reported	30199999	lb/ton produced		Water Scrubbing		18.4	Ref.1, Vol.I, pg. 33				
Acetic Acid (CO Methanol No Fugitive Reported	30199999	lb/ton produced		Incineration		0.0	Ref.1, Vol.I, pg. 67				
Acetic Acid (Butane) Fugitive not Quantified	30199999	lb/ton produced		Scrubbing and Flaring		76.5	Ref.1, Vol.I, pg. 85				
Acetic Acid (Acetaldehyde) Fugitive Classed As Very Minor	30199999	lb/ton produced		Absorbers and Collection of Pump Seal Losses		19.7	Ref.1, Vol.I, pg. 101				
Acetone	30109101	lb/ton produced									
Acetylene	30199999	lb/ton produced									
Acrylates	30199999	lb/ton produced									
Acrylonitrile (SOHIO)	30199999	lb/ton produced	214-330 (Fug.= 1)	Thermal Incinerator (on absorber vent and Flare	99.5%	1.0	Ref.2, Vol.2	Thermal Incinerator + Waste Heat Boile and Flare	99.5%	1.0	ef. 2 ol. 2
Alchohol	30199999	lb/ton produced									
Alkylated Liquor	30199999	lb/ton produced									
Ammonia (Methanator) No Fugitive Reported	30100201	lb/ton produced	90.0	Incineration	99%	0.9	Ref. 3				

DATA REFERENCES:

1. Survey Reports on Atmospheric Emissions from the Petrochemical Industry, Volumes 1-IV, Air Products and Chemicals, Inc., Houdry Div., January 1974.
2. Engineering and Cost Study of Air Pollution Control for the Petrochemical Industry, Volumes 1-9, Air Products and Chemicals, Inc., Houdry Div., February, 1975.
3. Controlled and Uncontrolled Emission Rates and Applicable Limitations for Eighty Processes, The Research Corporation of New England, September, 1976.

NOTE: Uncontrolled emission factor for process includes fugitive emission factor if reported.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Butadiene-Synthetic Rubber	30102601	lb/ton produced	40.0	Vapor Recovery/ Recycle	92%	3.1	Ref. 4 & Ref. 1, Vol.IV, Pg. 150				
Caprolactam	30199999	lb/ton produced									
Carbon Black (Furnace-Gas) Fugitive Not Quantified	30100503	lb/ton produced	1800	Flare		10.4	Ref. 2 Vol. 1	Incinerator/ Waste Heat Boiler		0	Ref. 2 Vol. 1
Carbon Black (Furnace-Gas/Oil) Fugitive Not Quantified	30100505	lb/ton produced		Flare		10.4	Ref. 2 Vol. 1	Incinerator/ Waste Heat Boiler		0	Ref. 2 Vol. 1
Cumene	30199999	lb/ton produced									
Cyclohexanone (Cyclohexane) Fugitive Termed Negligible	30199999	lb/ton produced		Recycle/Scrubbing Condenser, Incinerator		78	Ref.1,Vol.II pg. 64	Incineration		11.8	Ref. 20
Ethyl Benzene	30199999	lb/ton produced									
Ethyl Chloride	30199999	lb/ton produced									
Ethylene Dichloride (Oxychlor.)* Fugitive Not Reported	30112501	lb/ton produced	54.6	Thermal Incinerator + Scrubber and Condenser + Flare		0.2	Ref. 2 Vol. 3	Thermal Incinerator + Waste Heat Boiler + Scrubber and Condenser + Incinerator		0.0	Ref. 2 Vol. 3

DATA REFERENCES:

4. Impact of New Source Performance Standards on 1985 National Emissions from Stationary Sources, The Research Corporation of New England, October 1976

* Vinyl chloride monomer emissions not adequately considered.

NOTE: Uncontrolled emission factor for process includes fugitive emission factor if reported.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Ethylene Dichloride (Direct)*	30112502	lb/ton produced	9.7 (Fug.= 1.4)	Condenser + Scrubber		2.3	Ref.1, Vol.II pg. 151				
Ethylene (Pyrolysis)	30199999	lb/ton produced	(Fug.= 0.4)	K.O. Drums, Incinerators, Flares, and Scrubber		1.44	Ref.1, Vol.II pg. 132				
Ethylene Oxide	30199999	lb/ton produced	392.0 (Fug.=				Ref. 2 Vol. 6	Incineration (Thermal or Catalytic)	99%	3.92	Ref. 2 Vol. 6
Formaldehyde (Silver)	30112001	lb/ton produced	(Fug.= 0.5)	Plume Burner or Water Scrubber		2.5	Ref. 2 Vol. 4	Incineration and Recycle		1.8	Ref. 2 Vol. 4
Formaldehyde (Mixed Oxide) Fugitive Not Quantified	30112002	lb/ton produced	18.4	Incineration		2.8	Ref. 2 Vol. 5	Incineration + Recycle		1.0	Ref. 2 Vol. 5
Glycerol (allyl Chloride-Epichlorohydrin) Fugitive not quantified	30199999	lb/ton produced	134.9	Sodium Hydroxide Scrubbers		131.6	Ref.1, Vol.II pg.190,199, 206				
Hydrogen Cyanide (Andrussow) Fugitive Termed Undetectable	30199999	lb/ton produced		Flares and Air Heater (except sample pot vents)		2.5	Ref.1, Vol.II pg. 229				
Maleic Anhydride (Benzene) Fugitive Not Quantified	30110001	lb/ton produced		Condenser, Scrubber, and Boiler/Incinerator		1.7	Ref.1, Vol.III pg. 37				
Nylon 6 (Caprolactam Polymer.) No Fugitive Reported	30102401	lb/ton produced		Condensers, Scrubbers, and Afterburners		0.0 (Caprolactum considered Aerosol -6.4	Ref.1,Vol.III pg. 57				

* Vinyl chloride monomer emissions not adequately considered.

NOTE: Uncontrolled emission factor for process includes fugitive emission factor if reported.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Nylon 6,6 (Nylon Salt Polymer.) Fugitive Not Quantified	30102401	lb/ton produced		Water Scrubbing	99.7% (Finishing Operation)	0.0 (Monomer Considered Aerosol-7.2	Ref.1,Vol.III, pg. 79				
Polyvinyl Chloride (Solvent)	30101801	lb/ton produced	35.6 (Fug.- 0.6)	Vapor Recovery & Lean Oil Scrubber(in series)	85%	5.3 (Fug.-0.6)	Ref. 2, Vol. 9	Absorption/ Adsorption/ Incineration	97%	1.08 (Fug.-0.6)	Ref. 5
Oxoalcohol No Fugitive Reported	30199999	lb/ton produced		Water Scrubbing and Flares		6.1	Ref.1,Vol.III, pg. 101				
Paint No Fugitive Reported	30101401	lb/ton produced	30.0	Thermal/Catalytic Oxidation	95%	1.5	ESED	Same as RACT	95%	1.5	ESED
Phenol (Cumene)	30199999	lb/ton produced	(Fug.- 1.2)	Absorber/ Scrubber/Incin. (with Condensers & K.O. Drums) and Flare		20.6	Ref.1,Vol.III pg. 145				
Polyethylene (High Density)	30101802	lb/ton produced	(Fug.- 40)	Flares (Reactor Section)		68.0	Ref.1,Vol.III pg. 169	Flare stacks/vents Comp. emissions to process imp., monitoring & maint.		5.0 (Fug - 1.0)	Ref. 21
Polyethylene (Low Density)	30101802	lb/ton produced	(Fug.- 20 Inc. Stg.)	Flares (Purification & Recovery)		32.0	Ref.1,Vol.III pg. 187	Flare stacks/vents Comp. emissions to process imp., monitoring & maint.		2.0 (Fug - 1.0)	Ref. 21
Polypropylene	30101802	lb/ton produced	(Fug.- 30 New Plt.)	Condensers/K.O. Drums & Flares		63.8	Ref.1,Vol.IV, pg. 41	Flare stacks/vents Comp. emissions to process imp., monitoring & maint.		5.0 (Fug - 1:0)	Ref. 21
Polyvinyl Chloride (Suspension)	30101801	lb/ton produced	78.4 (Fug.- 30.5)	Improved Stripping + Vapor Recovery & Lean Oil Scrubber (in series)&Fug.Cont.	80%	15.9 (Fug.- 9.7)	Ref. 2, Vol. 9	Absorption/ Adsorption/Incineration + Fugitive Controls	95+%	3.68 (Fug. - 3.2)	Ref. 5

DATA REFERENCES:

5. Standard Support and Environmental Impact Statement: Emission Standard for Vinyl Chloride, U.S. EPA, Emission Standards and Engineering Division, October, 1975.
21. Based on TACB permit data for new sources. ESED reviewed and approved these factors by assuming technology transfer from similar processes. (Memo from ESED to Ralph Grotelueschen, April 7, 1978.)

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NON METHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Polyvinyl Pyrilidon	30110101	lb/ton produced									
Propylene Oxide	30199999	lb/ton produced									
Styrene (Ethyl Benzene)	30199999	lb/ton produced	9.6 (Fug.-0.3)	Vapor Recovery System and Flares		0.4(est.)	Ref.1,Vol.IV, pgs. 109-117				
Sulfuric Acid (Chamber)	30102201	lb/ton produced	0.0								
Tetraethyl Lead	30199999	lb/ton produced									
Varnish No Fugitive Reported	30101503	lb/ton produced	160.0	Afterburner	95%	8.0	ESED				
Vinyl Acetate (Acetylene) No Fugitive Reported	30199999	lb/ton produced	59.9	Vapor Recovery/ Incineration	Device planned for future. No data available.		Ref.1,Vol.IV, pg. 155				
Vinyl Acetate (Ethylene) No Fugitive Reported	30199999	lb/ton produced		Flare		0.0	Ref.1,Vol.IV, pg. 185				
Vinyl Chloride (Balanced Process)*	30199999	lb/ton produced	9.0 (Fug.-2.4)	Waste Heat Boilers With Scrubber & Fugitive Controls	90%	0.9	Ref. 2, Vol. 8	Incineration/ Adsorption/ Absorption + Fug. Control	97%	0.28 (Fug.-.24)	Ref. 5
Waste Water Treatment	30199999	lb/ton produced									

* Includes Ethylene Dichloride production

NOTE: Uncontrolled emission factor for process includes fugitive emission factor if reported.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Chlorine - General and Other	30100701 & 30100799	lb/ton produced									
Cleaning Chemicals - Soap/Det. Spry. Dryr.	30100901	lb/ton produced									
Paint Mfg. - Other Mixing	30101499	lb/ton product	(30.0)	Thermal/catalytic oxidation	95%	(1.5)	ESED	Thermal/catalytic oxidation	95%	(1.5)	ESED
Varnish Mfg. - Other Mixing	30101599	lb/ton product		Afterburner	95%		ESED				
Plastics - Phenolic Resins Mfg.	30101899	lb/ton produced	7.5	Flare	95%	0.38	Ref. 3 and ESED				
Phthalic Anhydride	30101903	lb/ton produced		Afterburner	90-95%		Ref. 20	Wet Scrubber	99%		Ref. 21
Printing Inks - Mixers	30102099	lb/ton produced		Scrubber or condenser plus afterburner	90%		Ref. 9 & 3				
Adhesives - General	30105001	lb/ton product			80-99%		Ref.		99%		Ref.
Asbestos Chemical - Sealants	30111102	lb/ton product	0.0								
Trichloroethylene Dryer (Oven)	30199999	lb/ton product									
Petroleum Additives	30199999	lb/ton product									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY CHEMICAL MANUFACTURING (Continued)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Pharmaceuticals-Coating, Mixing, & Drying	30199999	lb/ton product									
Magnetic Tape Dryer	30199999	lb/ton product									
Pigment Tray Dryer	30199999	lb/ton product									
Synthetic Rubber - Auto Tires General	30102620	lb/ton product		Collection system w/carbon adsorption + incineration/carbon adsorption + use of waterborne materials	89.5-91.3%		Ref. 10	Same as RACT	91.3%		Ref. 10
Sulfonic Acid General and Sulfonates	30111001	lb/ton product									
Formaldehyde (Silver)	30199999	lb/ton product	see	SCC 30112001							
Agricultural Chemical Mfg. Bldg. Vent	30199999	lb/ton product									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PRIMARY METALS

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Coke Met. Byproduct - General	30300301	lb/ton coal charged	2.7	Stage charging & scrubber for coal preheater	84%	0.44	Ref. 21	Same as RACT	94%	0.15	Ref. 21

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NON METHANE HYDROCARBONS INDUSTRY PRIMARY METALS

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Coke Oven Fugitive	30300399	lb/ton coal charged	2.5	Stage Charging	86%	0.34	Ref. 21	Stage Charging	98%	0.05	Ref. 16 and Ref. 21
Coke Met. Byproduct-Oven Charging	30300302	lb/ton coal charged	2.5	Stage Charging	86%	0.34	Ref. 21	Stage Charging	98%	0.05	Ref. 21

DATA REFERENCES:

16. "RACT and BACT Definitions Being Utilized in Contract 68-01-4344," Letter to Cheryl Wasserman from Pacific Environmental Services, Inc., February 1977.

21. Emission Factors and Control Technologies for Contract No. 68-01-4325, PEDCo Environmental, Inc., February, 1978

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY MINERAL PRODUCTS

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Asphalt Roofing - Cooling After Saturation	30500199	lb/ton saturated felt produced	(1.0)								

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM INDUSTRY

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Compressor Seal Fugitive	30600804	lb/10^3 bbl refinery capacity	5.0	Mechanical seals* (oil film) or packed glands (fo reciprocating comp.)	80%	1.0	Ref. 7	Mechanical seals* (oil film) or packed glands (fo reciprocating comp.)			Ref. 8
Cooling Tower Fugitive	30600701	lb/10^6 gal cooling water	6.0	Monitoring & maintenance program for heat exchangers	90% (assumed)	0.6	Ref. 6	Monitoring and maintenance program for heat exchangers	90% (assumed)	0.6	Ref. 8
Fluid Cracker	30600201	lb/10^3 bbl fresh feed	220.0	CO boiler and vent relief valves to flare	98%	4.4	Ref. 6	CO boiler and vent relief valves to flare	98%	4.4	Ref. 6
Miscellaneous Plant Fugitive Not Classified	30600805	lb/10^3 refinery capacity	10.0	Conscientious monitoring and maintenance program	90% (assumed)	1.0	Ref. 6	Conscientious monitoring and maintenance program	90% (assumed)	1.0	Ref. 6
Pipe/Valve Flange Fugitive	30600801	lb/10^3 ref. capacity	28.0	Conscientious monitoring and maintenance program	90%	2.5	Ref. 7	Same as RACT	90%	2.5	ESED
Process Drains W/ Control	30600501	lb/10^3 bbl waste water	8.0	N/A		N/A	N/A	N/A	N/A	N/A	N/A
Process Drains W/O Control	30600502	lb/10^3 bbl waste water	210.0	Seal openings and incorporate liquid traps*	96%	8	Ref. 7 & Ref. 9				
Process Heater (Gas)	30600104	lb/10^6 ft^3 burned	30.0	Combustion controls	90%	3	Ref. 6	Combustion controls	90%	3	Ref. 6
Pump Seals Fugitive	30600803	lb/10^3 bbl refinery capacity	17.0	Mechanical seals* (oil film) or equivalent-packed glands for reciprocating pump	91%	1.5	Ref. 7	Mechanical seals* (oil film) or equivalent-packed glands for reciprocating pump	95%	1.5	Ref. 8 and ESED

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NON-METHANE HYDROCARBONS INDUSTRY PETROLEUM INDUSTRY (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Vacuum Jets W/O Control	30600602	lb/10^3 bbl vacuum distillation	130.0	Vapor compression and combustion or incineration		Negligible	Ref. 7				
Vessel Relief Valve Fugitive	30600802	lb/10^3 refinery capacity	11.0	Conscientious monitoring and maintenance program	90-95%	1.1	ESED	Ruptyre disc or vent to flare		Negligible	Ref. 8

* Apply monitoring and maintenance program to these sources.

DATA REFERENCES:

6. The Impact of the Clean Air Act on Expansions of Petroleum Refinery, Petroleum Storage, and Selected Petrochemical Feedstock Facilities, (Draft), Volumes I and II, Radian Corporation, March 1977.
7. Control of Hydrocarbons From Miscellaneous Refinery Sources, (Draft), U. S. EPA, Emission Standards and Engineering Division, Chemical and Petroleum Branch, May 1977.
8. Evaluation of Pollution Potential of Proposed Hampton Roads Energy Company Refinery, Portsmouth, Virginia, Pacific Environmental Services, Inc., for U. S. EPA, November 1976.
9. Compilation of Air Pollutant Emission Factors, Supplements 1 through 7, U. S. EPA, AP-42, April, 1977

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM INDUSTRY (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Process Heater - Oil	30600101	lb/10^3 BBL oil burned	140	Combustion controls	95-99%	7.0	Ref. 20	Combustion controls	99.9%	0.14	Ref. 20
Blowdown System - Without Controls	30600402	lb/10^3 BBL refinery capacity	300	Vapor recovery or flare	98.3%	5.0	AP-42				
Fluid Coking	30699999	lb/BBL processed									
Asphalt Oxidizer General	30601101	lb/ton processed		Afterburner	90-95%		Ref. 20	Afterburner		95%	Ref. 20
Waste Gas Flare	30600999	lb/10^6 ft^3									
Gasoline Terminal Vapor Recovery	30699999	lb/BBL processed		Vapor recovery or incineration	90-99%		Ref. 13,6,63	Same as RACT	99%		Same as RACT

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY LEATHER AND TEXTILE MANUFACTURING

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Finish Coating	32099999	lb/ton processed									
General Fabrics	33000199	lb/ton processed									
Rubberized Fabric - Hot Melt Coating	33000203	lb/ton processed									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY INDUSTRIAL PROCESS-OTHER/NOT CLASSIFIED

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
PVC Tape Fabrication	39999999	lb/ton processed									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY POINT SOURCE EVAPORATION - CLEANING SOLVENT

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Degreasing-Misc. Solvents	40100299	lb/ton solvent	1900	Equipment modifications and prope operating procedures	20-70%	1045 (nationwide average)	Ref. 10 & Ref. 11	Same as RACT but additional modifications	70%	798 (Nationwide average)	Ref. 10 Ref. 11
Degreasing-Trichloroethane	40100202	lb/ton solvent	1900	Equipment modifications and prope operating procedures	20-70%	1045 (nationwide average)	Ref. 10 & Ref. 11	Same as RACT but additional modifications	70%	798 (Nationwide average)	Ref. 10 Ref. 11
Surface Wiping	40100399	lb/ton solvent									

DATA REFERENCES:

10. Air Pollution Control Technology Applicable to 26 Sources of Volatile Organic Compounds, U. S. EPA, Emission Standards and Engineering Division, May 1977 (Nationwide average from personal communication with Chemical and Petroleum Branch, July, 1977)

11. Control of Volatile Organic Solvent Metal Cleansing Operations, U.S. EPA, ESED, Chemical and Petroleum Branch, April, 1977.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY POINT SOURCE EVAPORATION

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Cleaning Solvent - Drycleaning - Perchloroethylene	40100101	lb/ton clothes cleaned	550	Carbon adsorption and good operating and maintenance practices	81-90%	106	Ref. 9	Same as RACT but better operating and maintenance practices	90%	56	Ref. 9
Surface Coating - Paint Solvent General	40200199	lb/ton solvent in coating	2,000	Carbon adsorption or afterburner	80-95%	400	Ref. 20	Thermal incineration	95%	100	Ref. 20
Surface Coating - Primer General	40200601	lb/ton coating	1,320	Carbon adsorption or afterburner	90%	132	Ref. 20	Thermal incineration	95%	66	Ref. 20
Surface Coating - Adhesive General	40200799	lb/ton solvent in coating	2,000	Carbon adsorption or afterburner	90%	200	Ref. 20	Thermal incineration	95%	100	Ref. 20
Surface Coating - Oven	40200801, 40200802, 40200803,& 40200899	lb/ton coating		Direct flame afterburner	92%		Ref. 20	Direct flame afterburner	99%		Ref. 20
Surface Coating - Solvent	40200901, 40200902, 40200921,& 40200922	lb/ton solvent	2,000	Carbon adsorption or incineration	80-95%	400	Ref. 20	Carbon adsorption or incineration	95%	100	Ref. 20
Surface Coating - Trichlor. Scotchguard on Woven Fabric	40299999	lb/ton coating		Incineration or carbon adsorption	80-95%		Ref. 20	Incineration or carbon adsorption	95%		Ref. 20
Surface Coating - Rubber on Fabric - Spreader Coater	40299999	lb/ton coating		Incineration or carbon adsorption	80-95%		Ref. 20	Incineration or carbon adsorption	95%		Ref. 20
Surface Coating - Printing on Metal Foil and Leaf	40299999	lb/ton coating		Incineration or carbon adsorption	85-90%		Ref. 10	Incineration or carbon adsorption	90%		Ref. 10

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY POINT SOURCE EVAPORATION (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Surface Coating - Solvent Cleaning of Metal	40299999	lb/ton coating		Equipment modifications and proper operating procedures	20-70%		Ref. 10 & Ref. 11	Same as RACT but additional modifications	70%		Ref. 10 & Ref.11
Surface Coating - Lacquer Isopropyl Alcohol and Other	40200404 & 40200499	lb/ton coating	2000	Incineration/Low or No Solvent Coating/Carbon Adsorption/Combination	70-95%	600	Ref. 10 and 15 and ESED	Same as RACT	95%	100	ESED

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBON INDUSTRY POINT SOURCE EVAPORATION - SURFACE COATING

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Enamel - General	40200501	lb/ton coating	840	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	168	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	42	ESED
Lacquer - General	40200401	lb/ton coating	1540	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	70-95%	462	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	77	ESED
Paint - Ethyl Acetate	40200103	lb/ton solvent in coating	2000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	400	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	100	ESED
Paint - General	40200101	lb/ton coating	1120	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	224	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	56	ESED
Paint - MEK	40200104	lb/ton solvent in coating	2000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	400	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	100	ESED
Paint - Solvent General	40200199	lb/ton solvent in coating	2000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	400	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	100	ESED

DATA REFERENCE:

15. Control of Volatile Organic Emissions from Existing Stationary Sources, Volume I and Volume II (Preprint), U.S. EPA, ESED, Chemical and Petroleum Branch, November, 1976.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBON INDUSTRY POINT SOURCE EVAPORATION -SURFACE COATING (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Solvent - MEK	40200918	lb/ton solvent	2000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	80-95%	400	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	100	ESED
Varnish/Shellac-General	40200301	lb/ton coating	1000	Incineration/Low or No Solvent Coat./Carbon Adsorption/Combination	75-95%	250	Ref. 10, Ref. 15 and ESED	(Same as RACT)	95%	50	ESED

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM PRODUCT STORAGE EVAPORATION

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Fixed Roof Breathing-Benzene	40300108	lb/10^3 gal. stg. cap./yr.	18.3	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	0.68	Ref. 10, 9 & 6	Same as RACT	98.5%	0.27	Ref. 10 9, & 6
Fixed Roof Breathing-Crude Oil	40300102	lb/10^3 gal. stg. cap./yr.	54.8	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	2.65	Ref. 10, 9 & 6	Same as RACT	98.5%	1.06	Ref. 10 9, & 6
Fixed Roof Breathing-Cyclohexane	40300109	lb/10^3 gal. stg. cap./yr.	20.8	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	0.76	Ref. 10, 9 & 6	Same as RACT	98.5%	0.30	Ref. 10 9, & 6
Fixed Roof Breathing-Distillate Oil	40300107	lb/10^3 gal. stg. cap./yr.	Very low								
Fixed Roof Breathing-Gasoline	40300101	lb/10^3 gal. stg. cap./yr.	80.3	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	3.02	Ref. 10, 9 & 6	Same as RACT	98.5%	1.21	Ref. 10 9, & 6

*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM PRODUCT STORAGE EVAPORATION (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Fixed Roof Breathing-Hexane	40300112	lb/10^3 gal. stg. cap./yr.	32.1	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	1.19	Ref. 10, 9 & 6	Same as RACT	98.5%	0.48	Ref. 10 9 & 6
Fixed Roof Breathing-Jet Fuel	40300105	lb/10^3 gal. stg. cap./yr.	25.2	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	90-98.5%	1.10	Ref. 10, 9 & 6	Same as RACT	98.5%	0.44	Ref. 10 9 & 6
Fixed Roof Breathing-Kerosene	40300106	lb/10^3 gal. stg. cap./yr.	Very low								
Fixed Roof Working-Benzene	40300153	b/10^3 gal. hruput	2.0	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Crude Oil	40300104	b/10^3 gal. hruput	7.3	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9

*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM PRODUCT STORAGE EVAPORATION (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Fixed Roof Working-Cyclohexane	40300154	b/10^3 gal. hruput	2.3	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Distillate Oil	40300152	b/10^3 gal. hruput	Very low								
Fixed Roof Working-Gasoline	40300103	b/10^3 gal. hruput	9.0	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Hexane	40300157	b/10^3 gal. hruput	3.6	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Jet Fuel	40300150	b/10^3 gal. hruput	2.4	Vapor recovery or floating roof with tight primary and secondary seals inc. maint. & inspection of seal gaps	~100%	Negligible	Ref. 9	Same as RACT	~100%	Negligible	Ref. 9
Fixed Roof Working-Kerosene	40300151	b/10^3 gal. hruput	Very low								

*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM PRODUCT STORAGE EVAPORATION (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT* METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Floating Roof Standing-Crude Oil	40300203	lb/10^3 gal. stg. cap./yr.	10.6	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps	75-90%	2.65	Ref. 10	Same as RACT	90%	1.06	Ref. 10
Floating Roof Standing-Gasoline	40300201	lb/10^3 gal. stg. cap./yr.	12.1	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps	75-90%	3.02	Ref. 10	Same as RACT	90%	1.21	Ref. 10
Floating Roof Standing-Jet Fuel	40300205	lb/10^3 gal. stg. cap/yr.	4.38	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps	75-90%	1.10	Assumed from Ref. 10	Same as RACT	90%	0.44	Assumed from Ref. 10
Floating Roof Working-Crude Oil	40300204	lb/10^3 gal. thruput	Negligible	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps		Negligible	Ref. 9	Same as RACT		Negligible	Ref. 9
Floating Roof Working-Gasoline	40300202	lb/10^3 gal. thruput	Negligible	Incorporation of tight primary and secondary seals inc. maint. & inspection of seal gaps		Negligible	Ref. 9	Same as RACT		Negligible	Ref. 9

*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY (POINT SOURCE EVAPORATION) PETROLEUM PRODUCT STORAGE (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Fixed Roof Breathing Oxo-Alcohol	40300198	lb/10^3 gal storage cap/yr									
Fixed Roof Breathing - Slop Oil	40300198	lb/10^3 gal storage cap/yr									
Fixed Roof Working - Oxo-Alcohol	40300199	lb/10^3 gal throughput									
Fixed Roof Working - Slop Oil	40300199	lb/10^3 gal throughput									
Floating Roof - Standing Loss - Distillate Fuel	40300207	lb/10^3 gal storage cap/yr	Very low								
Floating Roof - Standing Loss - Light Naphtha	40300299	lb/10^3 gal storage cap/yr	4.38	Incorporation of tight primary and secondary seals including maintenance and inspection of seal gaps*	75-90%	1.10	Ref. 10 (assumed)	Same as RACT*	90%	0.44	Ref. 10 (assumed)
Fixed Roof - Number 6 Oil	40399999	lb/10^3 gal	Very low								
Floating Roof - Standing Loss - Benzene	40300208	lb/10^3 gal storage cap/yr	2.7	Incorporation of tight primary and secondary seals including maintenance and inspection of seal gaps*	75-90%	0.68	Ref. 10 (assumed)	Same as RACT*	90%	0.27	Ref. 10 (assumed)

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*Internal floating cover also considered RACT and under consideration for LAER.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY POINT SOURCE EVAPORATION - PRINTING PRESS

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Dryers - General	40500101	lb/ton solvent		Incineration, carbon adsorption or ink substitution	80-90%		Ref. 10	Incineration, carbon adsorption, or ink substitution	90%		Ref. 10
Flexographic - General	40500301	lb/ton ink	1300	Incineration or substitute waterborne inks	80-85%	260	Ref. 10	Incineration or substitute waterborne inks	85%	195	Ref. 10
Flexographic - Ethyl Alcohol & N-Propyl Alcohol	40500304 & 40500306	lb/ton solvent in ink	2000	Incineration or substitute waterborne inks	80-85%	400	Ref. 10	Incineration or substitute waterborne inks	85%	300	Ref. 10
Lithographic - General	40500401	lb/ton ink	700	Incineration carbon adsorption or ink substitution	85-90%	105	Ref. 10	Incineration carbon adsorption or ink substitution	90%	70	Ref. 10
Lithographic - Solvent General	40500499	lb/ton solvent in ink	2000	Incineration, carbon adsorption, or ink substitution	85-90%	300	Ref. 10	Incineration, carbon adsorption, or ink substitution	90%	200	Ref. 10
Gravure - General	40500501	lb/ton ink	1300	Incineration carbon adsorption or ink substitution	85-90%	195	Ref. 10	Incineration carbon adsorption or ink substitution	90%	130	Ref. 10
Gravure - MEK and Solvent General	40500506 & 40500599	lb/ton solvent in ink	2000	Incineration, carbon adsorption, or ink substitution	85-90%	300	Ref. 10	Incineration, carbon adsorption, or ink substitution	90%	200	Ref. 10

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM MARKETING-TRANSFER

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Marine Vessels-Load(1) Crude Oil	40600202	lb/10^3 gal. trans.	2.58	Submerged fill, slow initial fill, vapor collection & recovery or incineration	90-97%	0.26	Ref. 12 & Ref. 6	Same as RACT	97%	0.087	Ref. 6
Marine Vessels-Load(1) Distillate Oil	40600205	lb/10^3 gal. trans.	Very low								
Marine Vessels-Load(1) Gasoline	40600201	lb/10^3 gal. trans.	2.88	Submerged fill, slow initial fill, vapor collection & recovery or incineration	90-97%	0.26	Ref. 12, 6 & 8	Same as RACT	97%	0.087	Ref. 6& Ref. 8
Marine Vessels-Unload(1) Crude Oil	40600227	lb/10^3 gal. trans.	2.25	Vapor collection & recovery or incineration	90-95%	0.225	Ref. 6	Segregated ballast, disallow in port purging	100%	0.0	Ref. 8
Marine Vessels-Unload(1) Gasoline	40600226	lb/10^3 gal. trans.	2.52	Vapor collection & recovery or incineration	90-95%	0.225	Ref. 6	Segregated ballast, disallow in port purging	100%	0.0	Ref. 8
Tank Cars/Trucks-Splash Load Gasoline	40600101	lb/10^3 gal. trans.	12.4	Submerged fill & vapor recovery or incineration	96-99.7%	0.41	Ref. 13, 6 & 3	Bottom loading vapor collection & recovery or incin.	99.7%	0.041	Ref. 13 Ref. 3
Tank Cars/Trucks-Submerged Load Gasoline	40600126	lb/10^3 gal. trans.	4.10	Incineration or vapor recovery	90-99%	0.41	Ref. 13, 6 & 3	Bottom loading vapor collection & recovery or incin.	99%	0.041	Ref. 13 Ref. 3
Tank Cars/Trucks-Unload Gasoline	40600151	lb/10^3 gal. trans.	2.10	Closed loop balance system-recovery at bulk station	90-99%	0.21	Ref. 13, 6 & 3	Closed loop balance system-recovery at bulk station-vapor tight seals on veh.	99%	0.021	Ref. 13 3, & 14

(1) Control Technology for Marine Terminals Available on 4 to 6 Years. Uncontrolled Emission Factor for Barge Unloading is Zero.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM MARKETING-TRANSFER (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Marine Vessels-Load(1) Jet Fuel	40600203	$lb/10^3$ gal trans.	0.60	Submerged fill, slow initial fill vapor collection & recovery or incineration	57-86%	0.26	Ref. 12, 6 & 8	Submerged fill, slow initial fill, vapor collection & recovery or incineration	86%	0.087	Ref. 6 & Ref. 8
Marine Vessels-Load(1) Kerosene	40600204	$lb/10^3$ gal trans.	Very low								
Marine Vessels-Load(1) Various Petrochemicals	40600298	$lb/10^3$ gal trans.		Submerged fill, slow initial fill vapor collection & recovery or incineration		0.26	Ref. 6	Submerged fill, slow initial fill, vapor collection & recovery or incineration		0.087	Ref. 6
Marine Vessels-Unload Various Petrochemicals(1)	40600299	$lb/10^3$ gal trans.		Vapor collection and recovery or incineration		0.225	Ref. 6	Segregated ballast, disallow in-port purging	100%	0.0	
Tank Cars/Trucks-Splash Load Distillate	40600105	$lb/10^3$ gal trans.	Very low								
Tank Cars/Trucks-Splash Load Kerosene	40600104	$lb/10^3$ gal trans.	Very low								
Tank Cars/Trucks-Splash Load Various Petrochemicals	40600197	$lb/10^3$ gal trans.		Submerged fill & vapor collection & recovery		0.41	Ref. 6	Submerged fill & vapor collection & recovery		0.041	Ref. 6
Tank Cars/Trucks-Submerged Load Distillate	40600130	$lb/10^3$ gal trans.	Very low								
Tank Cars/Trucks-Submerged Load Various Petrochemicals	40600198	$lb/10^3$ gal trans.		Vapor collection & recovery or incineration		0.41	Ref. 6	Vapor collection & recovery or incineration		0.041	Ref. 6

(1) Control Technology for Marine Terminals Available on 4 to 6 Years. Uncontrolled Emission Factor for **Barge** Unloading is Zero.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY PETROLEUM MARKETING-TRANSFER (CONT'D.)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Tank Cars/Trucks-Unload Distillate	40600155	lb/10^3 gal. trans.	Very low								
Tank Cars/Trucks-Unload Various Petrochemicals	40600199	lb/10^3 gal. trans.		Closed loop balance system-recovery during loading		0.21	Ref. 6, 13, and 3	Same as RACT		0.21	Ref. 6, 13, and 3

DATA REFERENCES:

12. Background Information on Hydrocarbon Emissions From Marine Terminal Operations, Volumes I and II, Radian Corporation, For U. S. EPA, November 1976.

13. Control of Hydrocarbons From Tank Truck Gasoline Loading Terminals, (Draft), U. S. EPA, ESED, Chemical and Petroleum Branch, May 1977.

14. "The Control of Hydrocarbon Emissions From Gasoline Marketing Operations," Vincent J. Pitruzzello, U. S. EPA, Region II, Paper presented at Mid-Atlantic States Section of the Air Pollution Control Association, April 1977.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY SOLID WASTE

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
Government - Municipal Incinerator Multiple Chamber	50100101	lb/ton burned	1.5	None	0%	1.5	ESED	Good design and operating practices	99.9%	negligible	Ref. 20
Government - Municipal Incinerator Single Chamber	50100102	lb/ton burned	15	None	0%	15	ESED	Good design and operating practices	99.9%	negligible	Ref. 20
Industrial - Multiple Chamber Incinerator	50300101	lb/ton burned	3.0	None	0%	3.0	ESED	Good design and operating practices	99.9%	negligible	Ref. 20
Commercial/Institutional - Organic Waste Incinerator	50200505	lb/ton burned									

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NONMETHANE HYDROCARBONS INDUSTRY MINOR NON-INDUSTRIAL SOURCES

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
GASOLINE MARKETING											
Underground tank filling & breathing (service station)		lb/10^3 gal throughput	12.5 (splash) 8.3 (submerged)	Service Station (Phase 1) Closed loop balance system & submerged or bottom loading & vapor tight truck & tight fittings	84 (submerged) to 90% (splash)	1.3	Ref. 9, Ref. 3, Ref. 14, & Ref. 17	Same as RACT	84 (submerged) to 90% (splash)	1.3	Same as RACT
Vehicle refueling and spillage			9.7	Vehicle Refueling (Phase 2) Manifolded vapor balance system & tight seal at nozzle-tank interface	82-93%	1.8		Same as RACT except improved vehicle refueling efficiency & elimination of spillage	93%	0.7	
Combination			18 (submerged) 22.2 (splash)		83-89% (submerged) 86-91% (splash)	3.1			89% (submerged) 91% (splash)	2.0	
DRY CLEANING											
Petroleum (Stoddard)		lb/ton clothes cleaned	560	Carbon adsorption & good operating & maintenance practices	82-86%	100	Ref. 9	Same as RACT but better operating & maintenance practices	86%	80	Ref. 9
Perchloroethylene			550	Carbon adsorption & good operating & maintenance practices	81-90%	106	Ref. 9	Same as RACT but better operating & maintenance practices	90%	56	Ref. 9
Trichlorotrifluoroethane			50-90 (controlled)	Refrigeration & operating & maintenance practices	0%	90	Ref. 9	Same as RACT but better operating & maintenance practices	0%	50	Ref. 9

DATA REFERENCE:

17. "A Predictive Model for Estimating the efficiency of Vapor Balance Systems During Vehicle Refueling", J. Panzer, Exxon Research and Engineering Company, Paper presented at Mid-Atlantic States Section of the Air Polution Control Association, April 1977.

SUMMARY OF CONTROL TECHNOLOGIES FOR MAJOR POINT SOURCES

POLLUTANT NON METHANE HYDROCARBONS INDUSTRY MINOR NON-INDUSTRIAL SOURCES (CONT'D)

PROCESS DESCRIPTION	SOURCE CLASSIFICATION CODE (SCC)	PROCESS EMISSION UNITS	UNCONTROLLED EMISSION FACTOR	REASONABLY AVAILABLE CONTROL TECHNOLOGY				LOWEST ACHIEVABLE EMISSION RATE			
				ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE	ABATEMENT METHOD	RANGE OF CONTROL	EMISSION FACTOR	DATA REFERENCE
ASPHALT PAVING Volatile petroleum distillate evaporation	None	None	Varies with type of cutback	Emulsified asphalt substitution	99%	Negligible	Ref. 10	Same as RACT	Same as RACT	Same as RACT	Same as RACT
SURFACE COATING Not included in point source inventory - architectural	None	None	(2000 lb/ton solvent used)	Low solvent coatings (high solids or water base)	80-90%		Ref. 9 and Ref. 18	Same as RACT	90%		Same as RACT
OPEN BURNING	None	None	Varies with type of material burned	Discontinue practice. Dispose of material in sanitary landfill or with well-controlled incinerator.	99-100% (part. & HC) 65-100% (nitrogen oxides)			Same as RACT	Same as RACT		
ON-SITE INCINERATION	None	None		Discontinue practice. Dispose of material in sanitary landfill or with well-controlled incinerator.	99-100% (part. & HC) 65-100% (nitrogen oxides)			Same as RACT	Same as RACT		

DATA REFERENCE:

18. "Emission Inventory Impact and Cost of Implementation of Proposed Stationary Source Controls", Warren Crouse, Bay Area Air Pollution Control District, August 14, 1977.

APPENDIX D

GROWTH AND RETIREMENT SCHEDULES

The Houston metropolitan area is one of the fastest growing areas in the nation. Some reports indicate that its population has increased by nearly 30% since 1970. This increase in population has been coupled with an increase in industrial activity in the Houston-Galveston AQCR. A number of state and local planning agencies are charged with the responsibility of estimating economic activity over the next few decades. As part of this study, Engineering-Science met with these organizations and compiled information that would reflect industrial production expected between now and 1990. It was assumed that the growth trends experienced in the last decade would also prevail for the next 15 years.

This study does not consider whether the Houston area can sustain the growth rate experienced in the last decade because of any limitations imposed as a result of the Clean Air Act Amendments, industrial siting constraints, etc. Thus, we cannot examine the impact the Clean Air Act Amendments have had on curtailing any industrial growth in the Houston-Galveston AQCR.

With production data, estimates can be made of the future air pollution emissions. Presently, all new major point source growth in the AQCR is required by Texas law to have best available control technology (BACT). This has been considered synonomous with lowest achievable emission rate (LAER) technologies. Thus, by knowing the increase in production for various chemical or petroleum products, it is possible using the LAER control technology definitions to estimate future LAER emissions.

While many new facilities are being built in the area, several existing facilities are being shut down because of normal retirement. Taking sources out of operation was assumed to be the result of economic disadvantages of operating old equipment. These disadvantages may be due to a change in fuels and feedstocks that has been experienced in the last several years because of the oil embargo. The two issues of growth and retirement of new facilities will be examined more thoroughly below.

GROWTH SCHEDULES

Information was obtained from a number of agencies reflecting the anticipated growth in the chemical and petroleum refining industries for this area. Another EPA contractor is currently investigating 12 chemical manufacturing processes and has estimated growth for these specific industries. These data were considered the most recent and reflected announced plans as well as expansions which are necessary to meet overall supply and demand forecasts for this area and the nation.

Table D-1 summarizes the growth factors obtained that have been used to estimate future hydrocarbon emissions for Houston-Galveston. The asterisk (*) on growth factor refers to the specific factor that was used in this analysis. In addition to the data obtained from the EPA contractors, other information was secured from national publications as well as local planning agencies. A comparison of specific information for chemical products is illustrated in Table D-1. If no data were available for the specific process, the OBERS factor was used to estimate production between 1975 and 1990. OBERS factors are based on employment and earnings. The assumption of full employment was made by the Department of Commerce in establishing the OBERS projections.

The national publications tended to support the work of the EPA contractors in estimating future production levels for the chemical manufacturing processes. A number of articles reviewed indicated that the growth of these compounds is within one or two percent per year of the data that has been used in this analysis.

To make accurate forecasts of hydrocarbon emissions, it was necessary to have a specific breakdown of the chemical or petroleum product involved. The OBERS projection factors were used to predict future production levels by standard industrial classification (SIC) codes. The two-digit SIC projection factor was used to estimate the growth that would take place between 1974 and 1990. The series E factors were used in this analysis. Again, the assumptions of full employment and the co-relationship between emissions and production were also assumed.

TABLE D-1

GROWTH FACTORS FOR THE HOUSTON-GALVESTON AQCR

1975 to 1990

CATEGORY	GROWTH FACTORS (a)			
	PACE (c)	HYDROSCIENCE (c)	OBERS (d)	OTHER
Chemical Industry			2.08*	
Ethylene	2.38*			2.26(f)
Ethylene Oxide	2.04*	2.13		
LDPD	2.80*			
HDPE	3.00*			
Ethylene Dichloride	2.08*	1.89		1.68(g)
Ethylbenzene	1.95*	2.13		
Polypropylene	3.76*			
Propylene Oxide	1.81*			
Acrylonitrile	2.96*	3.07		2.81(g)
Isopropanol	1.62*			
Methanol	1.99*			
Ammonia	1.92*			
Styrene	-	2.13*		
Acetone	-	1.67*		
Formaldehyde	-	2.13*		2.61(g)
Maleic Anlydride	-	3.88*		
Phenol		2.41*		
Polyvinly Chloride				1.82 (g)
Petroleum Refining			1.46*	
Primary Metals			1.30*	
Manufacturing General			1.86*	
Population			1.31(b)	

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* Represents the growth factor used in this study.

(a) 1.2 represents a 20% growth from 1975 to 1990.

(b) The Houston-Galveston Area Council projection in 1974 showed a growth rate of 1.33 for manufacturing employment.

(c) Growth based on production capacities and not earnings, employment, etc.

(d) Based on employment and earnings.

(e) Using a growth rate of 7%/year. Vide Hydrocarbon processing, October 17, 1977, pp. 51-54.

(f) Petrochemicals, The Prodigious Costs of Facing the Future, Business Week, July 18, 1977, pp. 45-54.

(g) Houdry Reports (data from other sources dated 1971-1972).

Table D-2 summarizes all of the growth factors that were used for this analysis. Two sets of information were available from the Department of Commerce. Data were available for Brazoria, Fort Bend, Harris, Liberty, and Montgomery Counties. A separate set of information was available for Galveston. The location of new hydrocarbon sources was not a factor in this study because of the methodology used. It was presumed that one ton of hydrocarbons emitted anywhere in the Houston-Galveston AQCR would have some impact on the ambient air ozone levels.

RETIREMENT SCHEDULES

Under the EPA's AQMA guidelines, several procedures were available for estimating plant closings and retirement. The best possible source of specific plant information would be data obtained directly from the owners. It was not possible to acquire this data in the detail necessary for a comprehensive investigation of all point sources in the AQCR. However, on the questionnaire data reviewed by Engineering-Science which tabulated hydrocarbon emissions for all points within a plan, it was observed that increases were expected because of increases in production from all questionnaires reviewed. Of the plants investigated, none reported closing down a specific manufacturing process.

The second methodology recommended in the EPA guidelines suggests the use of Internal Revenue Service (IRS) data. This information establishes the depreciation (accepted by the U.S. Treasury Department) that is allowed to businesses having specific types of manufacturing processes. The EPA guidelines suggest that the IRS estimate of depreciated time in years be multiplied by two in order to estimate the overall useful life of a specific process. Uncorrected IRS data are summarized in Table D-3 for the types of manufacturing operations which exist in the Houston-Galveston AQCR. [1]

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[1] Depreciation Guidelines and Rules, U.S. Treasury Dept. IRS Publication No. 456, Washington, D.C., August 1964.

TABLE D-2

HOUSTON-GALVESTON GROWTH DATA(1)

SIC GROUP	INDUSTRIAL CATEGORY	GROWTH FACTOR 1974 - 1990 HOUSTON(2)	GALVESTON(3)
20xx	Food	1.33	1.26
22xx	Textiles		
23xx	Apparel		
24xx	Lumber	1.40	
26xx	Paper	1.52	
27xx	Printing	1.79	1.82
28xx	Chemicals	1.64	
29xx	Petroleum Refining	1.38	1.38
33xx	Primary Metals	1.20	1.60
34xx	Fabricated Metals	1.95	1.35
35xx	Machinery (excluding electrical)	1.69	.97
36xx	Electrical Machinery		
3719	Motor Vehicle Equipment	1.49	
3721-3799	Transportation Equipment	1.69	1.33
21, 30-32, 38,39xx	Other Manufacturing	1.89	2.66
49xx	Utilities	1.86	1.97
	Population	1.33	1.30

(1) Source: OBERS Series E Projections, DOC, April 1974

(2) Includes Brazoria, Fort Bend, Harris, Liberty, and Montgomery Counties

(3) Includes only Galveston County

TABLE D-3

ESTIMATED USEFUL LIFE OF VARIOUS FACILITIES AND EQUIPMENT

PROCESS	IRS DEPRECIATION PERIOD (YEARS)	ESTIMATED USEFUL LIFE (YEARS)
Cement Manufacturing	20	40
Chemical and Allied Products	11	22
Fabricated Metal Products	12	24
Feed and Grain Mill Products	17	34
Motor Vehicles and Parts	12	24
Paper and Allied Products	16	32
Petroleum Refining	16	32
Petroleum Marketing	16	32
Plastic Products	11	22
Primary Metals	18	36
Stone and Clay Products	15	30

based on the type of industry pervalent in the Houston-Galveston area, it would appear that all industry should be completely replaced in 25-40 years. The analysis in this study covered a period of 15 years. Theoretically, about one-third of the industry in the AQCR should be completely replaced in that period.

There are other factors which suggest that the retirement schedules predicted by the IRS would not hold true if certain policies presently being analyzed in this study were in effect. Because of the cost of air pollution control, it may be desirable to operate older equipment longer than normal. In essence, these policies tend to prolong the period over which equipment is normally phased out of operation because of obsolescence.

APPENDIX E

BASE YEAR AND PROJECTED EMISSION INVENTORIES

The base year used for this analysis was the calendar year 1975. For the purpose of this study, ES relied principally on the Texas Air Control Board (TACB) to supply the emission inventory for the Houston-Galveston AQCR. No attempt was made to verify the emissions other than the normal routine checks for consistency that are made in the course of any analysis. The main objective in establishing an inventory was to compile a list of the principal sources of nonmethane hydrocarbon (NMHC) emissions for each individual process in the Houston-Galveston AQCR.

Insofar as possible, we have tried to use computers in processing the prodigious amount of data collected on each individual process in this area. In some instances, the National Emission Data System (NEDS) computer tape was used as a basis for building the major point source inventory. The NEDS is compatible with the Emission Inventory Subsystem/Permit and Registration (EIS/P&R). ES uses this computer system and a number of auxiliary programs that work off the EIS/P&R master file. The system operates on an IBM 370/168 computer.

Estimating the contribution of fugitive hydrocarbon emissions from point sources has become extremely critical in developing an effective control program for any state or federal control agency. Establishing an inventory for these fugitive emissions is extremely difficult. An inventory may have gaps and it is only as good as measurements made by individual firms. The TACB had information on fugitive hydrocarbon emissions for the larger major point sources. These data were incorporated in the major point source inventory.

MAJOR POINT SOURCES

Base Year Emissions

When this project was initiated, the TACB staff had not finished processing the 1975 questionnaires which were returned from all industries in the state. As a result, a copy of the 1973 NEDS emission inventory was obtained from the TACB and processed on the ES computer system. This 1973 inventory provided some insight as to the kind of industry located in the

Houston-Galveston AQCR. Furthermore, it was used as a prioritization scheme for establishing those processes for which we would have to define RACT and LAER. The 1973 inventory contained HC emissions. Production information for many of the petrochemical firms in the area had been labeled confidential in the 1973 inventory.

The TACB staff had reviewed each of the 1975 questionnaire responses. They, in effect, had verified the calculations and assumptions submitted by industry officials in estimating emissions for each individual process. TACB staff used a form shown in Figure E-1 to summarize all of the emissions for a single process for each plant in the state.

The emissions provided on the form were broken down into three main categories and then further divided into nonmethane and methane emissions. The three main categories were:

- o Regulated Emissions
- o Unregulated Emissions
- o Fugitive Emissions

In addition, information could be supplied on upset/maintenance emissions, production rate, and percent of maximum production for that process. When possible, each of the processes was assigned a source classification code. These eight-digit codes are routinely used by EPA to describe a specific process or source of air pollution emission.

Although the questionnaire contained information on the abatement systems already installed at a facility, this information had not been summarized and, in general, was not available for this study. The type of control system presently installed at a plant was not a critical input for this analysis. However, other information, such as production data, was critical and had to be obtained for each process.

The information on HC emissions for calendar year 1975 was tabulated and a computer master file was created. Information on all major point source emissions in the Houston-Galveston AQCR was collected. Texas officials indicated that these sources represented more than 97% of all NMHC emissions from point sources in the study area.[1] Table E-1 summarizes the emissions

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[1] Personal communication, John Anderson, TACB, August 1977.

FIGURE E-1

PROCESS EMISSIONS

Name ______________________________ Account No. ____________

Process Description ______________________________ SCC Units __________

Emission Points: (Circle those which are regulated)

Stack or Vent ______________________________

Tank ______________________________

Flare ______________________________

Incinerator ______________________________

Fugitive ______________________________

	1973	1975
Total Carbon Compound Emissions		
Non-Methane Emissions		
Methane Emissions		
Upset/Maintenance Emissions		
Non-Methane		
Methane		
Regulated Emissions		
Non-Methane		
Methane		
Unregulated Emissions		
Non-Methane		
Methane		
Fugitive Emissions		
Non-Methane		
Methane		
Production Rate		
% Maximum Production		

TABLE E-1

SUMMARY OF NONMETHANE HYDROCARBON EMISSIONS FROM MAJOR POINT SOURCE GROWTH IN HOUSTON/GALVESTON

INDUSTRY/PRODUCT/PROCESS	REPORTED 1975 EMISSIONS (tons/year)	1975 PRODUCTION	COMPOUNDED GROWTH RATE %/yr	1990 PRODUCTION	ADDITIONAL PRODUCTION 1975-1990	ADDITIONAL LAER[b] EMISSIONS BY 1990 (tons/year)
CHEMICAL MANUFACTURING						
Ethylene	3,362	11,000 10^6 lbs[a]	6	26,000 M lbs	15,000 M lbs	5,400[b]
Olefins (includes some ethylene)	1,793		6			2,080[b]
Low Density Polyethylene	9,951	2,500[j]	7	7,000	4,500	2,250[k]
High Density Polyethylene	11,201	900[j]	8	3,000	2,100	2,620[k]
Ethylene Dichloride	1,941	4,800	5	15,600	10,800	2,640
Ethylene Oxide	34	900	5	1,800	900	880
Propylene Oxide	404	1,200[j]	4	2,200	1,000	80[b]
Polypropylene	2,971	800[j]	9	3,000	2,200	2,750[k]
Vinyl Chloride	6,438	1,800	2	2,400	600[c]	40
Polyvinyl Chloride	8,480	700	4	1,200	500	140
Butadiene - Synthetic Rubber	6,131	2,000	2	2,700	700	550[b]
Carbon Black	9,486	200	3	300	100	0
Styrene	443	3,900	6	10,400	6,500	650[b]
Formaldehyde	565	600	6	1,200	600	150
Acetaldehyde	1,163	400	8	1,300	900	4,140[b]
Acetic Acid	320	300	10	1,200	900	0[l]
Acetone[d]	643	400	3	700	300	110[b]
Cyclohexanone	2,733	300	8	900	600	1,770[k]
Caprolactam & Hydroxylamines	530	e	e	e	e	0

Chemical Manufacturing continued on next page.

See page 4 for footnotes

TABLE E-1

SUMMARY OF NONMETHANE HYDROCARBON EMISSIONS FROM MAJOR POINT SOURCE GROWTH (Cont'd) IN HOUSTON/GALVESTON

INDUSTRY/PRODUCT/PROCESS	REPORTED 1975 EMISSIONS (tons/year)	1975 PRODUCTION	COMPOUNDED GROWTH RATE %/yr	1990 PRODUCTION	ADDITIONAL PRODUCTION 1975-1990	ADDITIONAL LAER EMISSIONS BY 1990 (tons/year)
Ethylbenzene	54	2,900	5	5,600	2,700	10 ^{b}
Ammonia	47		4			20 ^{b}
Glycerine (& assoc. products)	3,389	250	3	350	100	3,290 ^{b}
Adlylated Liquor Distillation	1,851		5			1,970 ^{b}
Sulfuric Acid	1,878	800	0	800	0	0
All Other Chemicals	15,689^{f}	(n/a)	5	(n/a)	(n/a)	7,960
SUBTOTAL	(91,497)					(39,500)
PETROLEUM REFINING (640 M bbl)^{g}						
Fluid Catalytic Cracking	5,422	143 10^{6}bbl^{g}	0	143 M bbl^{g}	0	0
API Separators	577^{m}	200 10^{6}bbl	1	250 M bbl	50	200^{m}
Cooling Towers	1,905	e	e	e	e	0
Valves, Pumps & Fugitive Losses	19,625	(n/a)	1	(n/a)		2,350
Natural Gas Processing	1,568	450 10^{9} cu ft	0	450 10^{9}cu ft	0	0
PAINTING (ALL INDUSTRIES)	2,884		4			250
LOADING						
Gasoline (Includes Aviation	8,584		1			170
Crude Oil	6,248		1			10
Other Petroleum Products	111		2			0
Chemicals	1,461		5			300

TABLE E-1

SUMMARY OF NONMETHANE HYDROCARBON EMISSIONS FROM MAJOR POINT SOURCE GROUPS (Cont'd) IN HOUSTON/GALVESTON

INDUSTRY/PRODUCT/PROCESS	REPORTED 1975 EMISSIONS (tons/year)	1975 PRODUCTION	COMPOUNDED GROWTH RATE %/yr	1990 PRODUCTION	ADDITIONAL PRODUCTION 1975-1990	ADDITIONAL LAER EMISSIONS BY 1990 (tons/year)
OTHER POINT SOURCES						
Boilers (Including Turbines)	160		4			140[b]
In-plant Vehicles	403		4			350[b]
Process Heaters	23		4			20[b]
Other Metals Manufacturing	1,041[h]		2			30
Incinerators	5		4			0
Miscellaneous	12,257[i]		4			4,380[b]
STORAGE TANKS						
Petroleum Industry	17,657		1			1,940
Chemical Industry	10,286		5			7,420
GRAND TOTAL	181,710					57,060

TABLE E-1

SUMMARY OF NONMETHANE HYDROCARBON EMISSIONS FROM MAJOR POINT SOURCE GROWTH (Cont'd)

HOUSTON/GALVESTON

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[a] 10^6 - Million pounds - applicable for all chemical manufacturing production rates.

[b] In general, there was no LAER factor available for most chemical manufacturing processes. In these cases, the RACT factors were used.

[c] Solvent process.

[d] Does not include production or emissions for Shell Chemical, Deer Park, Texas.

[e] No production data or growth information found.

[f] Represents 2,581 tpy regulated, 7,004 tpy unregualted, and 6,104 tpy fugitive emissions.

[g] Estimated from published data from the American Petroleum Institute.

[h] Of this total, 1,031 tpy comes from coke ovens.

[i] Represents 1 tpy regulated, 2,571 tpy unregulated, and 9,685 tpy fugitive emissions.

[j] These production rates were estimated for the Houston-Galveston area using published data.

[k] LAER control factors were based on recent permit data submitted to the TACB. EPA's ESED reviewed and approved these factors.

[l] All future production was assumed to be manufactured from CO methanol.

[m] Base year emissions were abnormally high and probably in error for one plant, according to the TACB. the projected 1990 LAER emissions were obtained using data from all other API separators except for the one mentioned.

by various chemical or manufacturing processes for the sources operating in the Houston-Galveston area.

Table E-2 summarizes the emissions according to the TACB definitions of regulated, unregulated, and fugitive emissions. The table illustrates the importance of controlling fugitive HC emissions because this category constitutes 44% of all major point source emissions in the AQCR.

Emissions from storage tanks were included in a separate file. The TACB developed a master data file for information on all storage tanks and then used a computer program to calculate HC emissions. The TACB data file contained the following information:

- Company name and the information code
- Tank number
- Tank type (e.g., fixed, floating)
- Chemicals stored
- Capacity of tank
- Monthly throughput
- Vapor pressure of liquid
- Category of tank (size and type)
- Months in operation

Using the EPA calculation procedure outlined in AP-42 (Supplement 7), the TACB computed annual emissions by inputing ambient temperature change and average wind speed as required in AP-42. Not all of these data were available because of confidentiality considerations. However, the TACB did provide emission data summaries. One summary printout of emissions is illuatrated in Table E-3. Emissions from the TACB were then adjusted to reflect more accurate calculation techniques for HC losses from storage tanks now under development by EPA.[1]

Securing Confidential Production Information

The major point source inventory consisted of approximately 150 plants. Of this total, 22 indicated that their production data should be kept confidential by the TACB. Accordingly, production information for these 22 companies

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[1] Tank emissions were adjusted for the purpose of this study and do not necessarily represent an established EPA methodology for calculating emissions as of this date. For the January 1979 SIP submittal, most EPA Regional offices are suggesting the use of AP-42 (Supplement 7), with no such adjustments.

TABLE E-2

SUMMARY OF REGULATED, UNREGULATED, AND FUGITIVE EMISSIONS[a]

TYPE	MAJOR POINT SOURCE EMISSION (tpy)	% OF TOTAL
PROCESSES		
Regulated	7,804	4
Unregulated	65,254	36
Fugitive	80,713	44
Subtotal	(153,771)	(85%)
STORAGE TANKS	27,939	15
Total	181,710	100%

[a] As defined by the TACB

TABLE E-3

SUMMARY TABLE OF HC LOSSES FROM STROAGE TANKS USING THE TACB COMPUTER FILE

VAPOR PRESSURE RANGE (psia)	MONTHLY THROUGHPUT (1,000 gal/month)	HC EMISSION[a] (tons/year)
Fixed Roof Tanks		
0 - 1.5	2,827,146	12,299
1.5 - 3.0	286,174	7,074
3.0 - 4.5	110,360	4,689
4.5 - 6.0	23,454	1,138
6.0 - 7.5	39,830	3,622
7.5 - 9.0	22,211	2,211
9.0 - 11.5	3,542	648
11.5 - 13.0	34	5
13.0+	13,019	3
	3,325,770	31,689
Floating Roof Tanks		
0 - 1.5	896,807	608
1.5 - 3.0	324,300	680
3.0 - 4.5	484,135	1,206
4.5 - 6.0	488,633	1,037
6.0 - 7.5	737,554	4,820
7.5 - 9.0	494,029	2,553
9.0 - 11.5	285,883	2,493
11.5 - 13.0	2	7
13.0+	0	0
	3,711,343	13,404
TOTAL	7,037,113	45,093[b]

[a] As reported by the TACB.

[b] These emissions were adjusted for use in this study. This figure was reduced to 27,939 tpy (17,657 tpy for the petroleum industry and 10,282 tpy for the chemical industry). See Table E-1.

could not be obtained directly from the TACB. A special effort was made to secure this confidential information directly from the sources.

EPA Region VI and ES contacted each of the 22 sources by mail and requested that they release the confidential production information (page 8 of the TACB questionnaire) for use in this study. Each source was advised that the information collected would not be used in any type of enforcement action against them and that it was intended to evaluate the impacts of the alternative new source nonattainment policies under study in this report for the President.

Several companies supplied the confidential information directly, many requested that a secrecy agreement be established before any data could be released. The information collected was kept under lock and key at ES's office. Only key employees had access to the information and none of it was ever reproduced or xeroxed for any other purposes. All confidential information collected had been aggregated and in no way can be identified with any specified process or plant as part of this study. Confidential data will be returned to the companies upon completion of this study.

Production data were obtained for all sources. In instances where no production data were obtained, published information from a variety of sources was relied on. These included magazine articles from Hydrocarbon Processing, Business Week, Hydrosciences' (contractors to EPA) published information in the technical journals, and past reports of the chemical and petroleum industries. Production information was essential because of the method for calculating emissions after additional controls are imposed. The emission factor concept was used; thus, emissions were determined by an activity indicator, such as production or capacity of a particular product.

Projected Year Emissions

Using the methodology described in Appendix D, emissions were projected from 1975 through 1990. The production change between 1975 and 1990 had just been completed. Since Texas law requires all new plants to use the best available control technology (BACT), it was assumed that all new emissions that will result from meeting higher production levels will be at LAER. The 1990 emissions for each manufacturing process have also been summarized in Table E-1. The compounded growth rate (%/year) is identical to the growth factors in Table D-1 when calculated for the 15 year period, 1975-1990.

Permit data were available for 1976 and a portion of 1977. The projected emissions using the methodology and growth factors described earlier for this 2 year period were about 7,000 tpy. The newly permitted emissions for 1976 and 1977 authorized by TACB were 11,234 tpy. The permit data were reviewed and several instances were found where controls did not meet the LAER definition used in this study. If the LAER assumptions were applied, the TACB permitted emissions would have been 9,511 tpy. Thus, the 1976-1977 historical growth in emissions appears to have been underestimated when compared with the calculated growth in emissions for the same time period. In order to compensate for potential errors in growth rates, several sensitivity analyses were performed using higher and lower growth rates than the best estimates tabulated from published sources.

AREA SOURCES

Base Year Emissions

The 1975 baseline NMHC emission inventory, Table E-4, was projected from the 1973 area source inventories provided by the TACB with two exceptions: emissions from dry cleaning and asphalt paving cutbacks, neither of which was included in the TACB inventory. The HC emissions from the former were estimated using the factor of 2 lbs/person year from AP-42 Section 4.1 dated February 1972.[1]

Emissions from asphalt cutbacks were based on information provided by the Texas Department of Highways and Public Transportation. A total of 8,970 tons of cutback were used in the AQCR in 1975--3,954 tons of medium cure and 5,016 tons of rapid cure. No slow cure cutback was used. The volatile section of the cutback was 19.25% by weight for medium cure and 24.5% by weight for rapid cure. Total AQCR emissions were allocated to counties in accordance with vehicle miles traveled (VMT) in each county.

Projected Year Emissions

The baseline year emission inventory was calculated by the use of emission factors applied to surrogate parameters, e.g., population. The same relationships were assumed to remain constant for the projection years 1980,

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[1] A revision of Section 4.1 dated April 1977 does not provide an emission factor based on population.

TABLE E-4

1975 HYDROCARBON EMISSIONS (TONS/YEAR)

	REGION	AUSTIN	BRAZORIA	CHAMBERS	COLORADO	FORT BEND	GALVESTON	HARRIS	LIBERTY	MATAGORDA	MONTGOMERY	WALKER	WALLER	WHARTON
RESIDENTIAL FUEL	833	4	40	4	5	20	54	635	10	9	28	9	4	11
COMM/IND FUEL	322	2	16	1	2	8	21	245	4	3	10	4	2	4
INTERNAL COMBUSTION	1	0	0	0	0	0	0	0	0	0	0	0	0	1
OPEN BURNING	315	45	0	43	56	0	0	0	0	43	0	32	47	49
INCINERATION	83	0	1	0	1	2	6	66	1	1	3	1	0	1
STRUCTURAL FIRES	21	0	0	0	0	1	2	18	0	0	0	0	0	0
WILD FOREST FIRES	496	0	0	10	0	0	0	55	136	0	169	108	18	0
AGRIC. TILLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNPAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOLVENT EVAPORATION	5,746	28	273	28	37	140	367	4,373	72	59	195	66	31	77
FUEL HANDLING	12,843	164	674	294	257	499	715	8,322	316	234	530	261	185	392
DRY CLEANING	2,827	14	133	14	18	69	179	2,155	36	29	96	32	15	37
ASPHALT PAVING	1,990	23	99	38	34	72	116	1,349	42	25	89	40	25	38
TOTAL	25,477	280	1,236	432	410	811	1,460	17,218	617	403	1,120	553	327	610

1985, and 1990. Consequently, projected emissions for each source category were estimated from the projection formula,

$$E_i = \frac{P_i}{P_{1975}} \times E_{1975},$$

where E_i is the emissions for 1980, 1985, or 1990 and P_i is the value of the surrogate parameter for 1980, 1985, or 1990. P_{1975} and E_{1975} are the values of the parameter for 1975 and source category emissions for 1975, respectively.

The parameter and sources of information for projections are briefly described below.

- Population projections by county were taken from An Economic Base Analysis of the Gulf Coast State Planning Region, Bureau of Business Research, University of Texas, December 1974.
- Projections for forested land and tilled agricultural acreage were taken from the Regional Environmental Analysis, Texas Parks and Wildlife Department, December 1975.
- The 1975 usage of cutback asphalts was 60% of historical usage because of funding limitations imposed upon the Texas Department of Highways and Public Transportation. It was estimated by Department officials that usage would return to normal by 1980 and remain constant through 1990.
- Fuel handling losses were projected at one-half the growth rate for VMT to reflect the increased fuel efficiency expected over the 1975 to 1990 time period.

The 1980, 1985, and 1990 projected NMHC emissions are summarized in Tables E-5, E-6, and E-7, respectively.

MOBILE SOURCES

Base Year Emissions

Mobile sources include all road vehicles such as cars, trucks, motorcycles, and buses. In addition, the mobile source emission category includes other mobile sources such as off road vehicles (mainly construction vehicles, farm tractors, etc.), airplanes, ships, boats, and rail locomotives. Emissions from

TABLE E-5

1980 HYDROCARBON EMISSIONS (TONS/YR)

	REGION	AUSTIN	BRAZORIA	CHAMBERS	COLORADO	FORT BEND	GALVESTON	HARRIS	LIBERTY	MATAGORDA	MONTGOMERY	WALKER	WALLER	WHARTON
RESIDENTIAL FUEL	960	4	47	5	5	25	57	738	11	9	36	8	4	11
COMM/IND FUEL	370	2	18	1	2	10	22	284	4	3	14	4	2	4
INTERNAL COMBUSTION	1	0	0	0	0	0	0	0	0	0	0	0	0	1
OPEN BURNING	323	45	0	47	57	0	0	0	0	45	0	29	50	50
INCINERATION	98	0	2	0	1	3	6	77	1	1	5	1	0	1
STRUCTURAL FIRES	25	0	1	0	0	1	2	21	0	0	0	0	0	0
WILD FOREST FIRES	486	0	0	10	0	0	0	52	134	0	165	107	18	0
AGRI TILLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNPAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOLVENT EVAPORATION	6,618	29	321	31	38	176	386	5,076	77	61	252	60	33	78
FUEL HANDLING	14,379	177	763	317	277	565	770	9,416	340	252	600	281	199	422
DRY CLEANING	3,253	14	156	15	18	86	188	2,501	38	30	124	29	16	38
ASPHALT PAVING	3,316	38	165	63	57	120	193	70	42	148		67	42	63
TOTAL	29,829	309	1,473	489	455	986	1,624	20,413	675	443	1,344	586	364	668

TABLE E- 6

1985 HYDROCARBON EMISSIONS (TONS/YR)

	REGION	AUSTIN	BRAZORIA	CHAMBERS	COLORADO	FORT BEND	GALVESTON	HARRIS	LIBERTY	MATAGORDA	MONTGOMERY	WALKER	WALLER	WHARTON
RESIDENTIAL FUEL	1,068	5	56	5	6	29	59	819	12	9	43	9	5	11
COMM/IND FUEL	412	2	22	1	2	12	23	316	5	3	16	4	2	4
INTERNAL COMBUSTION	1	0	0	0	0	0	0	0	0	0	0	0	0	1
OPEN BURNING	344	51	0	51	59	0	0	0	0	45	0	32	56	50
INCINERATION	109	0	5	0	1	3	6	85	1	1	5	1	0	1
STRUCTURAL FIRES	29	0	2	0	0	1	2	24	0	0	0	0	0	0
WILD FOREST FIRES	476	0	0	9	0	0	0	50	133	0	161	105	18	0
AGRI TILLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNPAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOLVENT EVAPORATION	7,363	32	387	33	39	204	404	5,636	82	62	303	65	37	79
FUEL HANDLING	16,104	190	863	341	298	639	830	10,653	367	272	678	303	215	455
DRY CLEANING	3,622	16	188	17	19	100	197	2,777	40	31	149	32	18	38
ASPHALT PAVING	3,316	38	165	63	57	120	193	2,248	70	42	148	67	42	63
TOTAL	32,844	334	1,688	520	481	1,108	1,714	22,608	710	465	1,503	618	393	702

TABLE E-7

1990 HYDROCARBON EMISSIONS (TONS/YR)

	REGION	AUSTIN	BRAZORIA	CHAMBERS	COLORADO	FORT BEND	GALVESTON	HARRIS	LIBERTY	MATAGORDA	MONTGOMERY	WALKER	WALLER	WHARTON
RESIDENTIAL FUEL	1,168	5	64	5	6	33	61	896	12	9	51	10	5	11
COMM/IND FUEL	452	3	25	1	2	14	23	346	5	3	19	4	3	4
INTERNAL COMBUSTION	1	0	0	0	0	0	0	0	0	0	0	0	0	1
OPEN BURNING	361	57	0	55	59	0	0	0	0	45	0	34	61	50
INCINERATION	122	0	7	0	1	4	7	93	1	1	6	1	0	1
STRUCTURAL FIRES	32	0	2	0	0	2	2	26	0	0	0	0	0	0
WILD FOREST FIRES	464	0	0	9	0	0	0	47	131	0	156	104	17	0
AGRI TILLING	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNPAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PAVED ROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOLVENT EVAPORATION	8,058	36	440	36	39	233	414	6,170	85	62	355	69	40	79
FUEL HANDLING	18,043	205	976	368	321	723	894	12,053	395	293	768	326	231	490
DRY CLEANING	3,965	18	214	18	19	115	202	3,040	42	31	174	34	20	38
ASPHALT PAVING	3,316	38	165	63	57	120	193	2,248	70	42	148	67	42	63
TOTAL	35,982	362	1,893	555	504	1,244	1,796	24,919	741	486	1,677	649	419	737

ships represent stack emissions and are not associated with either loading or unloading of any petroleum cargo. The category labeled boats was assumed to consist of pleasure craft.

Annual data indicating estimates of the vehicle miles traveled (VMT) were obtained from the Houston Galveston Regional Transportation Study (HGRTS) Office for Harris County and the State Department of Highways and Public Transportation for the other 12 counties. Table E-8 summarizes the 1975 VMT for two categories: urban and rural. Total urban VMT in the AQCR for 1975 were 13,069 x 10^6; rural VMT were 5,069 x 10^6.

EPA's MOBILE 1 emission factor program was used to calculate NMHC emissions from road vehicles using the VMT data in Table E-8. The MOBILE 1 program was recently issued from EPA's Office of Transportation and Land Use Policy (OTLUP) and is intended to supersede AP-42, Supplements 3 and 5. The program was developed to calculate the weighted emission factor (grams per vehicle mile traveled) of all cars, light duty trucks, heavy duty trucks, and other road vehicles using both gasoline and diesel fuel. There are many input variables which may be supplied to the MOBILE 1 program to calculate the emission factors. If the input variables are not supplied by the user, then the program assumes default values which were designed to represent the national average conditions. The more important input variables are:

- Fraction of VMT for LDV, LDT_1, LDT_2, HDG, HDD, MC
- Average speed (according to Federal Test Procedure)
- % Cold starts (noncatalyst equipped vehicles)
- % Hot and cold starts (catalyst equipped)
- % Vehicles with air conditioners (LDV, LDT_1, LDT_2)
- % Vehicles with 500 lb. extra load
- % Vehicles hauling trailers

Of those variables listed above, the estimate for speed seems to be the single most important item.

To get some idea of the difference these input variables make on the emission factor, a series of computer runs using the MOBILE 1 program was compiled. The inputs were varied in order to show how the emission factor changed. Table E-9 illustrates the results of the sensitivity analysis for 42 conditions for hydrocarbon emissions for calendar year 1977.

TABLE E-8

1975 ANNUAL VMT ESTIMATES

County	1975 Annual VMT (1,000,000) Urban	Rural	Total
Austin	26	164	190
Brazoria	328	477	805
Chambers	21	297	318
Colorado	25	247	272
Fort Bend	230	363	593
Galveston	418	609	1,027
Harris	11,484	1,365	12,849
Liberty	127	221	348
Matagorda	49	149	198
Montgomery	165	564	729
Walker	99	228	327
Waller	49	146	195
Wharton	48	239	287
	13,069	5,069	18,138

TABLE E-9

SUMMARY OF SENSITIVITY ANALYSIS OF MOBILE 1

	Year	Speed	Temp.	Cold / Hot Starts				EMISSION FACTORS						VMT MIX						Composite HC Emission Factor gms/mile
				PCCO	PCHS	PCCC		LDV	LDT$_1$	LDT$_2$	HDG	HDD	MC							
CAROLINA SEMINAR-1																				
1	77	55.0/55.0/55.0	80.	20.0	20.0	20.0	1	4.4	5.0	7.2	11.4	2.4	7.0	0.803	0.058	0.058	0.045	0.031	0.005	4.88
1	77	50.0/50.0/50.0	80.	20.0	20.0	20.0	1	4.5	5.1	7.3	11.6	2.4	7.2	0.803	0.058	0.058	0.045	0.031	0.005	5.00
1	77	35.0/35.0/35.0	80.	20.0	20.0	20.0	1	5.1	5.8	8.2	15.0	2.9	8.2	0.803	0.058	0.058	0.045	0.031	0.005	5.75
1	77	30.0/30.0/30.0	80.	20.0	20.0	20.0	1	5.6	6.3	8.9	17.8	3.3	9.0	0.803	0.058	0.058	0.045	0.031	0.005	6.32
1	77	15.0/15.0/15.0	80.	20.0	20.0	20.0	1	8.2	9.2	12.6	39.9	5.3	13.7	0.803	0.058	0.058	0.045	0.031	0.005	9.88
1	77	10.0/10.0/10.0	80.	20.0	20.0	20.0	1	10.9	12.2	16.6	59.2	6.5	18.7	0.803	0.058	0.058	0.045	0.031	0.005	13.39
1	77	55.0/55.0/55.0	40.	20.0	20.0	20.0	1	4.9	5.4	7.8	11.4	2.4	8.0	0.803	0.058	0.058	0.045	0.031	0.005	5.29
1	77	50.0/50.0/50.0	40.	20.0	20.0	20.0	1	5.0	5.6	8.0	11.6	2.4	8.2	0.803	0.058	0.058	0.045	0.031	0.005	5.42
1	77	35.0/35.0/35.0	40.	20.0	20.0	20.0	1	5.7	6.3	9.0	15.0	2.9	9.5	0.803	0.058	0.058	0.045	0.031	0.005	6.26
1	77	30.0/30.0/30.0	40.	20.0	20.0	20.0	1	6.2	6.9	9.7	17.8	3.3	10.4	0.803	0.058	0.058	0.045	0.031	0.005	6.89
1	77	15.0/15.0/15.0	40.	20.0	20.0	20.0	1	9.2	10.2	14.0	39.9	5.3	15.9	0.803	0.058	0.058	0.045	0.031	0.005	10.83
1	77	10.0/10.0/10.0	40.	20.0	20.0	20.0	1	12.3	13.7	18.6	59.2	6.5	21.9	0.803	0.058	0.058	0.045	0.031	0.005	14.74
1	77	55.0/55.0/55.0	80.	20.0	0.0	20.0	1	4.3	4.8	7.0	11.4	2.4	6.9	0.803	0.058	0.058	0.045	0.031	0.005	4.76
1	77	55.0/55.0/55.0	80.	20.0	20.0	0.0	1	4.0	4.5	6.5	11.4	2.4	6.9	0.803	0.058	0.058	0.045	0.031	0.005	4.47
1	77	55.0/55.0/55.0	80.	0.0	20.0	20.0	1	4.4	4.9	7.2	11.4	2.4	6.6	0.803	0.058	0.058	0.045	0.031	0.005	4.85
1	77	55.0/55.0/55.0	80.	10.0	10.0	10.0	1	4.1	4.6	6.8	11.4	2.4	6.7	0.803	0.058	0.058	0.045	0.031	0.005	4.60
1	77	55.0/55.0/55.0	80.	30.0	30.0	30.0	1	4.7	5.3	7.6	11.4	2.4	7.4	0.803	0.058	0.058	0.045	0.031	0.005	5.17
1	77	55.0/55.0/55.0	40.	20.0	0.0	20.0	1	4.7	5.3	7.6	11.4	2.4	7.8	0.803	0.058	0.058	0.045	0.031	0.005	5.17
1	77	55.0/55.0/55.0	40.	20.0	20.0	0.0	1	4.0	4.6	6.5	11.4	2.4	7.8	0.803	0.058	0.058	0.045	0.031	0.005	4.51
1	77	55.0/55.0/55.0	40.	0.0	20.0	20.0	1	4.8	5.3	7.8	11.4	2.4	6.6	0.803	0.058	0.058	0.045	0.031	0.005	5.21
1	77	55.0/55.0/55.0	40.	10.0	10.0	10.0	1	4.3	4.9	7.1	11.4	2.4	7.2	0.803	0.058	0.058	0.045	0.031	0.005	4.80
1	77	55.0/55.0/55.0	40.	30.0	30.0	30.0	1	5.4	6.0	8.5	11.4	2.4	8.8	0.803	0.058	0.058	0.045	0.031	0.005	5.78
1	77	15.0/15.0/15.0	80.	20.0	0.0	20.0	1	7.8	8.8	12.1	39.9	5.3	13.3	0.803	0.058	0.058	0.045	0.031	0.005	9.54
1	77	15.0/15.0/15.0	80.	20.0	20.0	0.0	1	7.3	8.3	11.1	39.9	5.3	13.3	0.803	0.058	0.058	0.045	0.031	0.005	9.05
1	77	15.0/15.0/15.0	80.	0.0	20.0	20.0	1	8.1	9.0	12.6	39.9	5.3	12.8	0.803	0.058	0.058	0.045	0.031	0.005	9.79
1	77	15.0/15.0/15.0	80.	10.0	10.0	10.0	1	7.5	8.5	11.6	39.9	5.3	12.9	0.803	0.058	0.058	0.045	0.031	0.005	9.25
1	77	15.0/15.0/15.0	80.	30.0	30.0	30.0	1	8.9	9.9	13.6	39.9	5.3	14.5	0.803	0.058	0.058	0.045	0.031	0.005	10.50
1	77	15.0/15.0/15.0	40.	20.0	0.0	20.0	1	8.8	9.9	13.5	39.9	5.3	15.5	0.803	0.058	0.058	0.045	0.031	0.005	10.49
1	77	15.0/15.0/15.0	40.	20.0	20.0	0.0	1	7.4	8.5	11.1	39.9	5.3	15.5	0.803	0.058	0.058	0.045	0.031	0.005	9.15
1	77	15.0/15.0/15.0	40.	0.0	20.0	20.0	1	9.0	9.9	14.0	39.9	5.3	12.8	0.803	0.058	0.058	0.045	0.031	0.005	10.64
1	77	15.0/15.0/15.0	40.	10.0	10.0	10.0	1	8.0	9.0	12.3	39.9	5.3	14.0	0.803	0.058	0.058	0.045	0.031	0.005	9.73
1	77	15.0/15.0/15.0	40.	30.0	30.0	30.0	1	10.3	11.5	15.7	39.9	5.3	17.8	0.803	0.058	0.058	0.045	0.031	0.005	11.93
CAROLINA SEMINAR-2																				
1	77	55.0/55.0/55.0	80.	20.0	20.0	20.0	1	4.4	5.0	7.2	11.4	2.4	7.0	0.660	0.124	0.084	0.058	0.072	0.002	4.99
1	77	15.0/15.0/15.0	80.	20.0	20.0	20.0	1	8.2	9.2	12.6	39.9	5.3	13.7	0.760	0.170	0.040	0.010	0.010	0.010	8.09
1	77	35.0/35.0/35.0	80.	20.0	20.0	20.0	1	5.1	5.8	8.2	15.0	2.9	8.2	0.660	0.124	0.084	0.058	0.072	0.002	5.90
1	77	35.0/35.0/35.0	80.	20.0	20.0	20.0	1	5.1	5.8	8.2	15.0	2.9	8.2	0.760	0.170	0.040	0.010	0.010	0.010	5.48
CAROLINA SEMINAR-3																				
1	77	35.0/35.0/35.0	80.	20.0	20.0	20.0	1	5.3	5.9	8.2	15.0	2.9	8.2	0.803	0.058	0.058	0.045	0.031	0.005	5.88
1	77	35.0/35.0/35.0	80.	20.0	20.0	20.0	1	5.2	5.8	8.2	15.0	2.9	8.2	0.803	0.058	0.058	0.045	0.031	0.005	5.82
1	77	35.0/35.0/35.0	80.	20.0	20.0	20.0	1	5.1	5.9	8.2	15.0	2.9	8.2	0.803	0.058	0.058	0.045	0.031	0.005	5.75
1	77	35.0/35.0/35.0	80.	20.0	20.0	20.0	1	5.1	5.8	8.3	15.0	2.9	8.2	0.803	0.058	0.058	0.045	0.031	0.005	5.76
1	77	35.0/35.0/35.0	80.	20.0	20.0	20.0	1	5.7	5.8	8.2	15.0	2.9	8.2	0.803	0.058	0.058	0.045	0.031	0.005	6.19
CAROLINA SEMINAR-4																				
1	77	55.0/55.0/55.0	80.	20.0	20.0	20.0	1	4.4	5.0	7.2	11.4	2.4	7.0	0.803	0.058	0.058	0.045	0.031	0.005	4.88

The 1975 emissions from all mobile sources for the AQCR and for each county in the AQCR are shown in Table E-10.

Projected Year Emissions

The HGRTS and the Texas Department of Highways and Public Transportation provided estimates of VMT from 1976 through 1990. The VMT increased from 18,138 x 10^6 to 38,039 x 10^6 between 1975 and 1990. This represents an overall increase of 110% or about 5% per year (compounded annually). Population during the same 15-year period is expected to increase by about 40%. If these projections of growth and travel are accurate, then, on the average, each person will travel 30 vehicle miles each day. At present, this figure is about 20 miles per person per day.

Emissions for the study years 1980, 1985, and 1990 were calculated using the MOBILE 1 emission factor program. In those scenarios where a strong I&M program was assumed, the "start" year for I&M was 1982. Tables E-11 through E-13 summarize the projected mobile source emissions. All other input variables such as speed, percent hot/cold starts, vehicle mix, etc., were assumed to be the same for the projection years as for the base year 1975.

MINOR POINT SOURCES

Base Year Emissions

No 1975 data were available from the TACB on emissions from minor point sources. Minor sources were defined for use in this study as those facilities which emitted less than 50 tpy NMHC emissions. A 1973/1974 computer tape containing emissions data was previously obtained from the TACB. Minor sources were selected from this tape and emissions summarized for the AQCR. About 200 plants and 500 processes comprised the minor source emission category. Minor source emissions were 2,395 tpy or about 1% of the major point source emissions.

Whereas the major source inventory consisted almost entirely of petroleum refining and chemical manufacturing emissions, minor point source emissions resulted from a variety of industrial processes, including field pumping stations, compressors, refractory manufacturing, agriculture dryers, rendering of animal fats, grain dryers, etc. There appears to be a distinct split

TABLE E-10

1975 MOBILE SOURCE EMISSIONS

NONMETHANE HYDROCARBONS

	Region	Austin	Brazoria	Chambers	Colorado	Fort Bend	Galveston	Harris	Liberty	Matagorda	Montgomery	Walker	Waller	Wharton
Road Vehicles -	121,116	1269	5375	2123	1816	3960	6858	85799	2324	1322	4868	2184	1302	1916
Off Road Vehicles	4444	45	304	227	133	188	239	2399	164	194	78	37	81	355
Rail Locomotives	1896	105	117	80	95	125	173	669	104	104	135	24	89	76
Aircraft	1784	0	10	3	3	2	11	1730	1	18	2	0	0	4
Ships	1002	0	118	79	0	0	351	373	0	81	0	0	0	0
Boats	4139	0	219	679	19	168	602	862	60	308	527	695	0	0
Total	134,381	1409	6143	3191	2066	4443	8234	91832	2653	2027	5610	2940	1472	2351

TABLE E-11

1980 MOBILE SOURCE EMISSIONS

NONMETHANE HYDROCARBONS

	Region	Austin	Brazoria	Chambers	Colorado	Fort Bend	Galveston	Harris	Liberty	Matagorda	Montgomery	Walker	Waller	Wharton
Road Vehicles	102,986[a]	1079	4571	1806	1544	3367	5831	72956	1976	1124	4139	1857	1106	1630
Off Road Vehicles	4444	45	304	227	133	188	239	2399	164	194	78	37	81	355
Rail Locomotives	2144	117	184	91	97	141	173	747	110	112	179	23	92	75
Aircraft	2452	0	12	4	4	2	14	2386	2	20	3	0	0	5
Ships	1104	0	159	90	0	0	351	417	0	87	0	0	0	0
Boats	4675	0	257	752	19	211	636	1001	64	320	680	735	0	0
Total	117,805	1241	5487	2970	1797	3909	7247	79906	2316	1857	5079	2652	1279	2065

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[a] No I&M program was assumed.

TABLE E-12

1985 MOBILE SOURCE EMISSIONS

NONMETHANE HYDROCARBONS*

	Region	Austin	Brazoria	Chambers	Colorado	Fort Bend	Galveston	Harris	Liberty	Matagorda	Montgomery	Walker	Waller	Wharton
Road Vehicles - Gasoline	60,572[a]	635	2688	1062	908	1980	3430	42909	1162	661	2435	1092	651	959
Off Road Vehicles	4444	45	304	227	133	188	239	2399	164	194	78	37	81	355
Rail Locomotives	2222	125	185	97	104	167	168	764	118	110	196	22	98	68
Aircraft	3317	0	15	5	5	3	17	3239	2	21	3	1	0	6
Ships	1154	0	187	96	0	0	341	444	0	86	0	0	0	0
Boats	5194	0	310	814	20	245	664	1111	67	325	818	820	0	0
Total	76,903	805	3689	2301	1170	2583	4859	50866	1513	1397	3530	1972	830	1388

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[a] No I&M program assumed

[b] With a strong I&M program in effect, these emissions are reduced to 50,352 tpy and the 'total' for mobile sources becomes 66,683 tpy.

[c] With the addition of a 20% VMT reduction achieved through a transportation control plan, and the strong I&M program, emissions are reduced to 40,426 tpy and the 'total' becomes 56,757 tpy.

TABLE E-13

1990 MOBILE SOURCE EMISSIONS

	Region	Austin	Brazoria	Chambers	Colorado	Fort Bend	Galveston	Harris	Liberty	Matagorda	Montgomery	Walker	Waller	Wharton
	NONMETHANE HYDROCARBONS*													
Road Vehicles	48,193[b,c]	505	2139	845	723	1576	2729	34140	925	526	1937	869	518	763
Off Road Vehicles	4444	45	304	227	133	188	239	2399	164	194	78	37	81	355
Rail Locomotives	2398	135	212	104	111	193	164	843	126	109	214	21	105	61
Aircraft	1095[a]	0	18	6	6	4	20	1003[a]	3	23	4	1	0	7
Ships	1205	0	214	103	0	0	332	471	0	85	0	0	0	0
Boats	5669	0	351	870	20	280	681	1216	70	324	958	897	0	0
Total	63,004	685	3238	2155	993	2241	4165	40072	1288	1261	3191	1825	704	1186

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[a] Reflects compliance with new aircraft emission standards

[b] With a strong I&M program in effect, these emissions are reduced to 33,183 tpy and the 'total' for mobile sources becomes 47,994 tpy.

[c] With the addition of a 20% VMT reduction achieved through a transportation control plan, and the strong I&M program, emissions are reduced to 26,546 tpy and the 'total' becomes 41,357 tpy.

between major and minor point sources in this AQCR in comparison with other cities studied. This is probably due to the predominance of the petroleum and chemical industries in this area.

Projected Year Emissions

Minor point source emissions were assumed to increase according to the OBERS growth factors for "manufacturing general" (Table D-1). Minor point sources already had RACT type controls for the few instances in which controls were required. Thus, the present minor point source emissions were projected to 1990 by proportioning from the 1975 emission levels (2,395 x 1.86 = 4,455 tpy). No further controls were applied to the additional 2,060 tpy (4,455 - 2,395) of emissions from minor point source growth. Growth of minor point source emissions was 4% of the growth of major point source emissions (at LAER) for 1990.

APPENDIX F

GLOSSARY OF TERMS

1. Inspection and Maintenance (I/M): This is an inspection and maintenance program of automobiles to ensure they are in compliance with the Federal Motor Vehicles Emissions Control Program.

2. Lowest Achievable Emission Rate (LAER): LAER is defined in the 1977 Amendments to the Clean Air Act as the more stringent of the lowest emission rates achieved in practice or the lowest SIP emission limitation achievable for a class or category of sources. It is currently required of all major new or modified sources requesting permission to construct in nonattainment areas. It will continue to be required by all states in nonattainment areas until NAAQS are achieved and maintained.

3. Major Stationary Source: Only new or modified "major" stationary sources are subject to the offset ruling or the Act's new nonattainment requirements. A new source or modification of an existing source is deemed to be a major source if it has the potential to emit (or increase emissions by) 100 tons per year or more of any pollutant. However, under EPA regulations, such sources which emit 50 tons per year or more after control will be subject to the offset ruling and Clean Air Act requirements.

4. National Ambient Air Quality Standards (NAAQS): EPA has established standards of permissible air quality concentrations of sulfur dioxide, particulate matter, ozone, carbon monoxide, and nitrogen dioxide. A standard was also established for hydrocarbon levels for use only as a guideline for the control of ozone. Primary standards protect the public health while secondary standards protect public welfare.

5. Nonattainment Area: An area which is shown by monitored data or which is calculated by air quality modeling to violate a NAAQS.

6. Offset Policy: EPA's December 21, 1976 interpretive ruling on growth in nonattainment areas. This ruling, which is continued by the 1977 amendments until July 1, 1979, requires that new emissions in such areas must be more than "offset" by concurrent emission reductions from existing sources in the area. The policy also provides that such new emissions must be reduced to the lowest achievable emission rate (LAER) and that credit for reductions from existing sources will be allowed only to

the extent that they go beyond what the applicable SIP already requires. The combination of LAER and offsets must lead to a net air quality improvement.

7. Potential Emissions: This is the level of emissions which would be generated if the source were operated at its design capacity without control equipment. At the present time, EPA's offset policy is phrased in terms of "allowable emissions", which clearly looks to the level of emissions after controls. EPA will incorporate this change into the existing offset policy even before the July 1979 deadline for SIP revisions.

8. Reasonable Available Control Technology (RACT): RACT is the level of pollution control technology on existing sources which takes both cost and technology into account. By law, it is the level of control that the states will adopt in revised implementation plans in 1979 subject to EPA approval. In some instances, it will provide for attainment of standards by 1982. In others, it will be more stringent at the state's discretion in order to provide an additional margin for growth.

9. Reasonable Further Progress (RFP): A requirement which must be included in the states' revised implementation plans for nonattainment areas. The term refers to annual incremental emission reductions which are sufficient to demonstrate attainment of the ambient air quality standards by the new 1982 deadline or 1987 extension. At a minimum, RFP requires emission reductions from existing sources as may be obtained through the adoption of "Reasonably Available Control Technology" (RACT).

10. State Implementation Plan (SIP): Each state is required to submit, for EPA's approval, an implementation plan outlining the state's strategy for attaining and maintaining the NAAQS within the deadlines established by the Clean Air Act.